III Semester

TRANSFORM TECHNIQUES AND FOURIER SERIES			
Course Code	1BBM301	Scheme	2025
Type of Course	Theory	Semester	III
Teaching Hours/Week (L:T:P)	3 : 2 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 28 : 0 : 50	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Solve First and Second-Order Ordinary Differential Equations
2. Evaluate Differential Equations and Systems Using Laplace Transforms
3. Analyze Periodic and Non-Periodic Signals Using Fourier Series and Transforms
4. Model Physical and Mechanical Systems Using Ordinary and Partial Differential Equations

Module-1

Ordinary Differential Equations: Basic Concepts. Modelling, Geometric Meaning of y= f'(x, y). Direction Fields, Euler's Method, Separable ODEs. Exact ODEs. Integrating Factors Second-Order Linear ODEs: Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Modelling of Free Oscillations of a Mass–Spring System

Number of Hours: 14

Module-2

Laplace Transforms: Laplace Transform. Linearity. First Shifting Theorem (s-Shifting) Transforms of Derivatives and Integrals. ODEs Unit Step Function (Heaviside Function). Second Shifting Theorem (t-Shifting) Short Impulses. Dirac's Delta Function. Partial Fractions Convolution. Integral Equations Differentiation and Integration of Transforms. ODEs with Variable Coefficients Systems of ODEs Laplace Transform: General Formulas

Number of Hours: 14

Module-3

Fourier Series: Arbitrary Period. Even and Odd Functions. Half-Range Expansions Forced Oscillations, Approximation by Trigonometric Polynomials Sturm–Liouville Problems. Orthogonal Functions, Orthogonal Series. Generalized Fourier Series, Fourier Integral 510

Number of Hours: 14

Module-4

Fourier Transform: Fourier Cosine and Sine Transforms Complex Form of the Fourier Integral, Fourier Transform and Its Inverse, Physical Interpretation: Spectrum, Linearity. Fourier Transform of Derivatives, Convolution, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT)

Number of Hours: 14

Module-5

Partial Differential Equations: Basic Concepts of PDEs, Modelling: Vibrating String, Wave Equation, Solution by Separating Variables, Use of Fourier Series, Modelling: Heat Flow from a Body in Space. Heat Equation, Heat Equation: Solution by Fourier Series. Heat Equation: Modelling Very Long Bars. Solution by Fourier Integrals and Transforms

Number of Hours: 14

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

Text books:

1. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.
2. B.S. Grewal: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018

Reference books / Manuals:

1. V. Ramana: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. Srimanta Pal & Subodh C. Bhunia:"Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.

Web links and Video Lectures (e-Resources):

- NPTEL – Fourier Series: https://www.youtube.com/watch?v=LGxE_yZYigI
- Laplace Transform: https://www.youtube.com/watch?v=j0wJBEZdwLs
- Introduction to PDEs: https://www.youtube.com/watch?v=O3ahEHAX-KU

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. Simulation and Virtual Labs
2. Flipped Classroom

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.	Programming Assignment	15
2.	Assignment (at RBL3, RBL4, or RBL5 levels)	10

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

Learning Activity: Programming Assignment					
Programming Assignment	Superior	Good	Fair	Needs Improvement	Unacceptable
Functionality PO 1, 2, 3, 5	Correct execution with the required complexity level.	Correct execution but not following exact algorithm/procedure	Program outputs are not correct, but attempts to follow implementation	Program does not follow required algorithm/procedure	Program does not execute
Code Quality PO 1, 2, 3, 5	Code is modular with sufficient documentation	Code is functional but not suitable for extension	Proper naming conventions are used, but code is not readable.	Code is completely unreadable.	Code is not complete and does not compile

Learning Activity: Assignment					
Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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.	Assignment	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ma54	20
2.	https://nptel.ac.in/courses/111104519	20

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).

DIGITAL DESIGN AND HDLs			
Course Code	1BBM302	Scheme	2025
Type of course	Theory	Semester	III
Teaching Hours/Week (L:T:P)	3: 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 : 0 : 28 : 50	SEE Marks	50
Credits	4	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Design digital systems for required functionality
2. Develop HDL designs for the digital blocks designed
3. Design and verify complex combinational and sequential logic blocks

Module-1

Principles of combinational logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps- up to 4 variables, Quine-McCluskey minimization Technique

Introduction to Verilog: Structure of Verilog module, Operators, data types, Styles of description- Data flow description, Behavioral description, Implement logic gates, half adder and full adder using Verilog data flow description.

Number of Hours: 8

Module-2

Combinational Functions: Arithmetic Operations: Adders and subtractors-cascading full adders, Look ahead carry, Binary Comparators – 2 bit and 4 bit, two bit Multiplier, Verilog Description of for above circuits. Multiplexers- Realization of 2:1, 4:1 and 8:1 using gates & Applications. Demultiplexers: - Realization of 1:2 1:4 and 1:8 using basic gates & Applications

Verilog Behavioral description: Structure, variable assignment statement, sequential statements, loop statements, Verilog behavioral description of Multiplexers and De-multiplexers

Module-3

Analysis and design of combinational logic: Encoders: Binary coded decimal codes, Binary – Gray vice versa, BCD – Excess 3 Encoders: Realization and Priority Encoders, Decoders: BCD – Decimal, BCD – Seven segment, seven segment display.

Verilog behavioral description: Encoders (8 to 3 with priority and without priority), Decoders (2 to 4).

Number of Hours: 8

Module-4

Sequential Logic Circuits-1: Latches and Flip-Flops: SR-latch, Dlatch, D flip-flop, JK flip-flop, T flip- flop Master slave FF, Edge trigger and Pulse trigger FF , Registers and Shift Registers: PISO,

PIPO, SISO,SIPO, Right shift and left shift, Universal Shift register.

Verilog behavioral description: Latches (D-latch, SR latch) and flipflops (D, T, JK, SR flip-flops).

Number of Hours:

Module-5

Counters, design and their applications: Counters-Binary ripple counters, Synchronous binary counters, Modulo N counters – Synchronous and Asynchronous counters.

Verilog behavioral description: Synchronous and Asynchronous counters, sequential counters. Synthesis of Verilog: Mapping process in the hardware domain Mapping of signal assignment, variable assignment, if statements, elseif statements, loop statements

Number of Hours:

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Simplification, realization of Boolean expressions using logic gates/Universal gates
2. Adder/Subtractor design using IC7483
3. Half-adder and full-adder design with Verilog
4. To realize the following flip-flops using NAND Gates (a) T type (b) JK Master slave (c) D type
5. To realize the 3-bit counters as a sequential circuit and Mod-N Counter design (7476, 7490, 74192, 74193)
6. Multiplexers/decoders/encoder using Verilog Behavioral description

1. 8-bit and 6-bit adder design with Verilog
2. Design of latches and flip-flops with Verilog
3. Creating Test-benches for Verilog Designs
4. Counter design with Verilog
5. Design of shift registers with Verilog
6. Loop statements for testing complex designs

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

Text books:

1. Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, Morris Mano, 6e (2018), Pearson Education
2. Verilog HDL, Samir Palnitkar, 2e (2003)Pearson

Reference books / Manuals:

1. Digital Logic Applications and Design by John M Yarbrough, Thomson Learning,2001
2. Fundamentals of HDL- Cyril P R Pearson/Sanguin 2010

Web links and Video Lectures (e-Resources):

- Virtual Labs: https://virtual-labs.github.io/exp-logic-simplification-iitkgp/
- Online Digital Logic Simulator: https://circuitverse.org/
- Online Verilog Compiler: https://www.edaplayground.com/

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. Virtual Labs
2. Mircoprojects

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 each from both Part A and Part B.

Rubrics for CIE – 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)

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Procedure (PO1)	Is knowledgeable about all aspects of the program, including execution and analysis of the results.	Is knowledgeable about the theoretical concepts and the procedure for execution of the program	Knows the Program, but is not knowledgeable about the theoretical concepts.	Is partially aware of the program, but is not capable of execution.	Is not aware of the procedure of the program.

Conduction (PO3 & PO5)	Executes the program and able to produce the required results and also modified setup for different input cases.	Executes the Program and able to produce the required results.	Executes the program, but not able to generate the required results.	Executes the program in an erroneous manner.	Unable to setup the program.

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.	Micro project	25
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://nptel.ac.in/courses/106103358	25

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).

ANALOG ELECTRONIC CIRCUITS			
Course Code	1BBM303	Scheme	2025
Type of Course	Theory	Semester	3
Teaching Hours/Week (L:T:P)	3 : 2 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 28 : 0 : 50	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Analyze BJT Amplifiers Using Small-Signal Hybrid Models
2. Design Biasing Circuits for Field Effect Transistors (FETs)
3. Evaluate the Frequency Response of Single-Stage and Multistage Amplifiers
4. Design and Differentiate Power Amplifiers and Feedback Oscillator Circuits

Module-1

BJT modeling: Common Emitter Configuration, Voltage-Divider Bias, CE Emitter-Bias Configuration, Emitter Follower Configuration, Determining Current Gain, Effect of RL and RS, Cascaded Systems, RC- Coupled BJT Amplifier, Cascade Connection, Darlington Connection. The Hybrid Equivalent model, Approximate Hybrid Equivalent Circuit, Fixed bias configuration, Voltage-Divider configuration. Complete Hybrid Equivalent Model and Hybrid Model.

Number of Hours: 8

Module-2

Field Effect Transistors: Introduction, Construction and Characteristics of JFETs, Transfer Characteristics, Applying Shockley's Equation. Depletion Type MOSFET: Basic Construction, Basic Operation andCharacteristics, P-Channel Depletion Type MOSFET and Symbols, Enhancement Type MOSFET: Basic Construction, Basic Operation and Characteristics, P-Channel Enhancement Type MOSFETs and Symbols.

CMOS-Basics: FET Biasing Introduction, Fixed-Bias Configuration, Self-Bias Configuration, Voltage-Divider Biasing. Relevant problems on above topics

Number of Hours: 8

Module-3

FET Amplifiers: Introduction, JFET Small Signal Model, JFET AC equivalent Circuit,
Fixed- Bias Configuration, Self-Bias Configuration, Voltage-Divider Configuration, Source Follower Configuration. Relevant problems on above topics.

BJT and JFET Frequency Response: Introduction, General Frequency Considerations, Low Frequency Response of BJT Amplifier, Low Frequency Response of FET Amplifier, Miller Effect Capacitance, High Frequency Response of FET Amplifier, Multistage frequency effects. Relevant problems on above topics .(Excluding P-spice Analysis)

Number of Hours: 8

Module-4

Power Amplifiers: Introduction: Definitions and Amplifier Types, Series Fed Class A Amplifier, Transformer Coupled Class A Amplifier, Class B Amplifier operation.

Class B amplifier circuits: Transformer-Coupled Push-Pull Circuits, Complementary –Symmetry Circuits only, Amplifier Distortion, Class C and Class D Amplifier.

Number of Hours: 8

Module-5

Feedback and Oscillator Circuits: Feedback Concepts, Feedback Connection Types, Effects of negative feedback, Oscillator operation, Phase Shift Oscillator: FET Phase Shift Oscillator, Transistor Phase Shift Oscillator, Wien Bridge Oscillator, Tuned oscillator Circuit: FET and Transistor Colpitts Oscillator, FET and Transistor Hartley Oscillator, Crystal oscillator. Relevant Problems on above topics Unijunction transistor oscillator.

Number of Hours: 8

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

Text books:

1. Robert L. Boylestad and Louis Nashelsky, "Electronics devices and Circuit theory", Pearson, 10th Edition, 2009, ISBN:9788131727003

Reference books / Manuals:

1. David A. Bell, "Electronic Devices and Circuits", Oxford University Press.
2. I. J. Nagrath, "Electronics: Analog and Digital", PHI

Web links and Video Lectures (e-Resources):

- Analog Electronic Circuits (Prof. Shanthi Pavan) https://youtube.com/playlist?list=PLyqSpQzTE6M9YEdrct_JIT8WWmGMEXcPA&si=-lSfSOj3_hX5pwRE
- Free Circuit Simulator: https://www.analog.com/en/resources/design-tools-and-calculators/ltspice-simulator.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. Problem Based Learning
2. Simulation and Virtual Labs

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.	Tool/Software Exploration	15
4.	Assignment	10

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

Learning Activity: Tool/Software Exploration					
Programming Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Operational Familiarity **PO 1, 5**	Completely fluent with all capabilities of the tool and to run simple and complex cases.	Tool is functional with examples, and is able to execute the examples.	Tool is partially functional for examples provided	Tool properly installed and running, but not able to run examples.	Not able to initiate the tool.
Functional Application **PO 1, 3, 4, 5**	Can create complex cases and is capable of debugging to produce the required outputs.	Can create moderately complex examples and simulate with the tool to produce the required outputs.	Can apply the tool to run simple examples and produce the output.	Can create partial examples and run on the tool.	Cannot use the tool.

Learning Activity: Assignment					
Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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.	Assignment	25
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://nptel.ac.in/courses/108102112	25

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

HUMAN ANATOMY AND PHYSIOLOGY			
Course Code	1BBM304	Scheme	2025
Type of Course	PCC	Semester	3rd
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Explain Cellular and Tissue-Level Homeostasis
2. Analyze Neuro-Muscular Coordination and Brain Functions
3. Explain the elements and functions of the cardiovascular system
4. Evaluate the Functional Anatomy of the Gastrointestinal and Musculoskeletal Systems

Module-1

Homeostasis: The internal environment and homeostasis, survival needs of the body, movement of substances within the body, body fluids, action potential, propagation of action potential, cell-structure and functions.

Tissue & Cartilage: Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage.

Number of Hours: 8

Module-2

Central nervous system: The Neuron, Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction, Meninges, ventricles of the brain and CSF.

The Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum, Brainstem, Cerebellum, Spinal cord, grey matter, white matter, spinal reflex, Spinal nerves, Cranial nerves, Autonomic nervous system, Pituitary gland and hypothalamus

Number of Hours: 8

Module-3

Cardiovascular System: Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart position, structure-pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation-aorta Summary of the main blood vessels

Number of Hours: 8

Module-4
Respiratory System: Organs of respiration, Nose and Nasal cavity position, Pharynx, Larynx, Trachea, bronchi, bronchioles and alveoli, Lungs. Respiration - muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes and capacity **Digestive System:** Organs of the digestive system – mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine, Pancreas and Liver Number of Hours: 8
Module-5
Skeletal System: Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column, features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb. **Muscles and Joints:** Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, Hip joint, Knee joint, ankle joint. Number of Hours: 8
Web links and Video Lectures (e-Resources): • Crash Course on Anatomy & Physiology: https://www.youtube.com/playlist?list=PL8dPuuaLjXtOAKed_MxxWBNaPno5h3Zs8 • Introduction to the human body: https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): Text books: 1. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 13th Edition, Churchill Livingstone Publications. Reference books / Manuals: 1. Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd. 2. Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, 3rd Edition, Jaypee Publications 3. Human Physiology: From Cells to Systems – by Lauralee Sherwood, 6th Edition, Thomson India Edition, 2007.

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. Periodic Guest Lectures by Medical Professionals
2. Apps like Complete Anatomy or Insight Heart where students can project a life-sized, 3D heart onto their table using a smartphone

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.	Case Study Presentation	15
2.	Simulation and Virtual Labs	10

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

Learning Activity: Case Study Presentation					
Case Study Presentation	Superior	Good	Fair	Needs Improvement	Unacceptable
Clarity of Explanation PO 1, 2, 3	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

Learning Activity: Simulation and Virtual Labs					
Virtual Labs	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Operational Familiarity **PO 1, 5**	Completely fluent with all capabilities of the tool and to run simple and complex cases.	Tool is functional with examples, and is able to execute the examples.	Tool is partially functional for examples provided	Tool properly installed and running, but not able to run examples.	Not able to initiate the tool.

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

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

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

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

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

Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar	12
2.	Assignment	12
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_bt05	24

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).

INSTRUMENTATION, MEASUREMENTS AND BIOMEDICAL TRANSDUCERS			
Course Code	1BBM305	Scheme	2025
Type of Course	PCC	Semester	3rd
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Explain the construction and working principles of Biomedical Transducers.
2. Choose Appropriate Transducers for Biological Signal Acquisition
3. Evaluate the performance of various Biomedical Transducers

Module-1

Basic of Transducers: Introduction, Classification of Transducers, Measurement, Signals and Noise in the measurement-Measurement, signals and noise, signal to noise ratio, different types of noise.

Characteristics of Measurement systems-Transducer and measurement system, static characteristics, dynamic characteristics, standard and calibration, accuracy and error.

Number of Hours: 8

Module-2

Bioelectric Signals: Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Bioelectric signals

Electrodes: Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

Number of Hours:

Module-3

Pressure Measurement: Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers. Physiological pressure ranges and measurement sites, Direct pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement
of systolic, diastolic, and mean blood pressure, Detection of Kortokoff sounds.

Number of Hours: 8

Module-4

Temperature Measurement: Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire and thin film thermo-resistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules.

Transducers and Sensors: Photoelectric Transducers: photovoltaic cells and photoemissive cells. Biosensors and Smart Sensors.

Number of Hours: 8

Module-5

Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue.

Number of Hours: 8

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

Text books:

1. Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.

Reference books / Manuals:

1. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

Web links and Video Lectures (e-Resources):

- NPTEL Playlist on Biomedical Instrumentation https://www.youtube.com/playlist?list=PLyqSpQzTE6M_rQyhzfm2XMKkFmwzDKKEo

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. Periodic Guest Lectures by Industry Professionals

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.	Case Study Presentation	15
2.	Assignment (at RBL3, RBL4, or RBL5 levels)	10

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

Learning Activity: Case Study Presentation					
Case Study Presentation	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

Learning Activity: Assignment					
Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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.	Micro project	12
2.	Assignment	12

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

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_bt49	24

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).

ANALOG ELECTRONICS CIRCUITS LAB		Scheme	2025
Course Code	1BBML306	Semester	3
Teaching Hours/Week (L:T:P)	0 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SLTW	0 : 0 : 28 : 0	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Design and test BJT and FET Amplifier Circuits
2. Characterize and Evaluate AC Performance Metrics and Frequency Bandwidth
3. Design and test oscillator circuits for given frequencies

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. To design and testing of the following rectifiers with and without filters: (a) Full Wave Rectifier (center tap) (b) Bridge Rectifier.
2. To plot characteristics of UJT and to determine its intrinsic stand-off ratio
3. To plot the Drain and Transfer characteristic for the given FET and to find the Drain Resistance and Trans-conductance.
4. To plot the input and output characteristics of n-channel MOSFET and calculate its parameters, namely; drain resistance, mutual conductance and amplification factor.
5. Testing of crystal oscillator and to determine its frequency of oscillation.
6. Verification of Thevenin's theorem and Maximum Power Transform theorem for the given DC circuits.

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 test common emitter amplifiers
2. Design and test Emitter follower amplifier
3. Design and test frequency response of Common Source JFET/MOSFET amplifier, and determine its bandwidth.

4. Design a Complimentary symmetry class B push pull power amplifier and calculate its efficiency.
5. Design and test RC-Phase shift Oscillator for a given frequency
6. Design and test the following tuned oscillator circuits for the given frequency (a) Hartley Oscillator (b) Colpitts Oscillator

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

Text books:

1. Robert L. Boylestad and Louis Nashelsky, "Electronics devices and Circuit theory", Pearson, 10th Edition, 2009, ISBN:97881317270

Reference books / Manuals:

1. Electronics Lab Manual by K. A. Navas, Volume I, PHI, 5th Edition, 2015, ISBN:9788120351424.
2. Electronics Laboratory Primer - A Design Approach by S.Poorna Chandra, B.Sasikala, S Chand Pub.

Web links and Video Lectures (e-Resources):

- Analog Electronic Circuits (Prof. Shanthi Pavan) https://youtube.com/playlist?list=PLyqSpQzTE6M9YEdrct_JIT8WWmGMEXcPA&si=-lSfSOj3_hX5pwRE
- Free Circuit Simulator: https://www.analog.com/en/resources/design-tools-and-calculators/ltspice-simulator.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. Project Based Learning

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 SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Procedure (PO1)	Is knowledgeable about all aspects of the experiment, including conducting and analysis of the results.	Is knowledgeable about the theoretical concepts and the procedure for conduction of the experiment.	Knows the procedure, but is not knowledgeable about the theoretical concepts.	Is partially aware of the procedure, but is not capable of conduction.	Is not aware of the procedure of the experiment.
Conduction (PO3 & PO5)	Conducts the experiment and able to produce the required results and also modified setup for different input cases.	Conducts the experiments and able to produce the required results.	Conducts the experiment, but not able to generate the required results.	Conducts the experiment in an erroneous manner.	Unable to setup the experiment.

- 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 for CIE				
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)

INSTRUMENTATION, MEASUREMENTS AND BIOMEDICAL TRANSDUCERS LAB			
Course Code	1BBML307	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	3
Teaching Hours/Week (L :T : P)	0 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0 : 0 : 28: 0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Evaluate Mechanical and Thermal Transducers under Static Conditions
2. Construct and Balance AC/DC Bridge Networks for Impedance Measurement
3. Measure and Interpret Physiological and Analytical Chemical Parameters

SET OF EXPERIMENTS

1. **Measurement of displacement using LVDT& determine its sensitivity and resolution.**
2. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.
3. Temperature measurement using AD590 / LM34
4. Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance
5. Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge.
6. Measurement of self-inductance using Maxwell's bridge.
7. Measurement of inductance and internal resistance of a choke by three voltmeter method.
8. Measurement of unknown capacitance using Schering's bridge.
9. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge configuration)
10. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP).
11. Measurement of unknown concentration of given solution/body fluid using Spectrophotometer and Colorimeter
12. Measurement of pH of a given solution/ body fluid using pH meter. (b)Determination of Conductivity of a given unknown solution/ body fluid using conductivity meter

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

Text books:

1. Electronic Instrumentation by H. S. Kalsi, TMH, 2004 (Module-2,3 & 4)
2. Electronic Instrumentation and Measurements by David A Bell, PHI / Pearson Education2006/ Oxford Higher Education, 2013. (Module 1& 3)

Reference books / Manuals:

1. Measurement systems application and design by E.O. Doebline 4th Edition, TMH.
2. Instrumentation for Process Measurement by Norman. A. Anderson, 3rd Edition, CRC
3. Principle of Measurement System by John. P. Bentley, 3rd Edition, Pearson, 2007
4. Handbook of Biomedical Instrumentation- R S Khandpur, 2ndedition, Tata McGraw Hill, 2003.

Web links and Video Lectures (e-Resources):
• Physiological Transducers: https://www.youtube.com/watch?v=PA-qoyEMLuY
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. Microproject 2. Virtual Labs

Assessment Structure:

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

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

Rubrics for CIE – Continuous assessment:

Rubrics for CIE				
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)

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Procedure (PO1)	Is knowledgeable about all aspects of the experiment, including conducting and analysis of the results.	Is knowledgeable about the theoretical concepts and the procedure for conduction of the experiment.	Knows the procedure, but is not knowledgeable about the theoretical concepts.	Is partially aware of the procedure, but is not capable of conduction.	Is not aware of the procedure of the experiment.
Conduction (PO3 & PO5)	Conducts the experiment and able to produce the required results and also modified setup for different input cases.	Conducts the experiments and able to produce the required results.	Conducts the experiment, but not able to generate the required results.	Conducts the experiment in an erroneous manner.	Unable to setup the experiment.

- 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**.

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)

B.E. in Biomedical Engineering
Scheme of Teaching and Examinations 2025
Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2025-26)

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching & Learning Scheme					Examination				Credits
					CI		LI	# TW & SL	TH/S	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P							
1	PCC	1BBM401	Data Acquisition Circuits	TD/PSB: ECE,/ECE	42	0	0	48	90	3	50	50	100	3
2	IPCC	1BBM402	Data Structures and Algorithms	TD/PSB: CS/CS	42	0	28	50	120	3	50	50	100	4
3	PCC	1BBM403	Biomechanics	TD/PSB: BM/BM	42	28	0	50	120	3	50	50	100	4
4	PCC	1BBM404	Embedded Controllers	TD/PSB: ECE/ECE	42	0	0	48	90	3	50	50	100	3
5	PCCL	1BBML405	Data Acquisition Circuits Lab	TD/PSB: ECE/ECE	0	0	28	02	30	2	50	50	100	1
6	AEC	1BBML406	Embedded Controllers Lab	TD/PSB: ECE/ECE	0	0	28	02	30	2	50	50	100	1
7	BSC	1BBM407	Biology for Engineers	TD / PSB: BM/BM	28	0	0	32	60	3	50	50	100	2
8	SDC	1BEP408	Environmental Science Project	TD/PSB	0	0	0	30	30	3	50	50	100	1
9	**PCC/PEC**	**1Bxx409**	**Control Systems Engineering**	**TD/PSB: BM/BM**	**42**	**0**	**0**	**48**	**90**	**3**	**50**	**50**	**100**	**3**
10	NCMC	1BNSK409	National Service Scheme (NSS)	Campus: NSS coordinator	0	0	0	28	28	--	100	---	100	PP
		1BPEK409	Physical Education (PE) (Sports and Athletics)	Campus: Physical Education Director										
		1BYOK409	Yoga	Campus: Yoga Teacher										
		1BMUS409	Music	Campus: Music Teacher										
				Total					598		550	450	1000	22
11	NCMC	1BMATDIP410	Mathematics course for Lateral Entry Students	TD/PSB -Maths Dept	14	0	0	14	28	--	100	--	100	PP
				Total					626		**650**	**450**	**1100**	22

Ability Enhancement Course (Laboratory) 1BxxL406x

1BxxL406A		1BxxL406C	
1BxxL406B		1BxxL406D	

 # TH/S- Total Hours per Semester, TW & SL- Term Work & Self Learning, ** The course 1BXXL406x – Ability Enhancement Course Laboratory can be offered either as a single compulsory course. Alternatively, the Ability Enhancement Course Laboratory course can be offered with multiple elective options under the course codes 1BXXL406x (where *x = A, B, C, D*). **Note to Chairpersons: If only one course is selected, the title of the course may please be entered at serial number 6 of the Scheme of Teaching and Examinations and the above table along with this row shall be deleted. In case, multiple courses are selected the above table shall be filled with the course titles and this row shall be deleted.**

IV Semester

DATA ACQUISITION CIRCUITS			
Course Code	1BBM401	Scheme	2025
Type of Course	Theory	Semester	4
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Design and characterise performance of amplifier circuits.
2. Design Waveform Generators, Converters, and Signal Processing Circuits
3. Evaluate Data Converters and Systems for Analog-to-Digital Interface

Module-1

Introduction to Operational Amplifiers: Introduction, Blockschematic of an Op-amp, Power supply connections, Characteristics of an Ideal OP-AMP, Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Differential Amplifier, CMRR. Summing amplifier, Subtractor, Instrumentation Amplifier.

Operational Amplifier Characteristics: DC characteristics – Input bias current, Input offset current, Input offset voltage, Total output offset voltage, Thermal drift. AC characteristics – Frequency response, Slew rate, PSRR.

Number of Hours: 8

Module-2

Operational Amplifier Applications: V – I and I – V converter, Opamp circuit using diodes, sample and hold circuit, Differentiator and Integrator.

Comparator and waveforms generator: Comparator, Regenerative comparator (Schmitt Trigger), Astable mutivibrator, Monostable multivibrator and Triangular waveform generator. Phase shiftoscillator, Wien bridge oscillator.

Number of Hours: 8

Module-3

Voltage Regulators: Introduction, Series Op-amp regulator, IC voltage regulators, general purpose regulators, switching regulator.

Active filters: First and Second order LPF, First and Second orders HPF, Band Pass Filters, Band Reject filters. (Design examples).

Number of Hours: 8

Module-4

555 Timer: Description of Functional Diagram, Monostable operation, Applications of Monostable Multivibrator: Frequency Divider & Pulse Width Modulation. Astable operation, Applications of Astable Multivibrator: FSK Generator and Pulse Position Modulation.

Phase Locked Loops: Basic Principles, Analog phase Detector/comparator, Voltage controlled oscillator. PLL applications: Frequency Multiplication/Division, Frequency translation, FM demodulation.

Number of Hours: 8

Module-5
Data Acquisition Systems: Types of instrumentation systems, Components of analog data acquisition system, Digital data acquisition system, Use of recorders in digital systems, Digital recording systems. **Data Converters:** Digital to Analog Converters: Basic DAC techniques, Weighted Resistor DAC, R – 2R Ladder DAC, DAC 0800 Analog to Digital Converters: Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC 0809 (Data sheet: Features, specifications and description only), DAC/ADC specifications. Number of Hours: 8
Suggested Learning Resources: (Text Book/ Reference Book/ Manuals): **Text books:** 1. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5) 2. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3) 3. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5) **Reference books / Manuals:** 1. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin &Fred. F. Driscoll, PHI/Pearson, 2006 2. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001 3. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005
Web links and Video Lectures (e-Resources): • https://www.youtube.com/watch?v=_xxx7fHNAoE
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. Virtual Labs 2. Flipped Classroom
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.	Seminars	10
2.	Assignment (at RBL3, RBL4, or RBL5 levels)	10

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

Learning Activity: Seminars					
Case Study Presentation	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

Learning Activity: Assignment					
Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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

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

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

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

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

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar	10
2.	Assignment	10

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

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Self Learning	28

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

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

DATA STRUCTURES AND ALGORITHMS			
Course Code	1BBM402	Scheme	2025
Type of course	Theory(IPCC)	Semester	4
Teaching Hours/Week (L:T:P)	3 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42 :0 : 28: 50	SEE Marks	50
Credits	4	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Design and Implement Core Data Structures
2. Apply Graph and Optimization Algorithms
3. Analyze iterative, recursive, and sorting algorithms

Module-1

Algorithmic Foundations and Linear Structures: Introduction to iterative and recursive algorithms, algorithm analysis and asymptotic notations, Abstract Data Types (ADTs), implementation and applications of stacks, operations and applications of queues, array implementation of circular queues, implementation of stacks using queues and queues using stacks, priority queue (concept and applications), applications of stacks, storage structures for arrays, sparse matrices.

Number of Hours: 8

Module-2

Linked Lists: Linked lists, singly, doubly and circular linked lists, search, insertion and deletion operations on linked lists, algorithms on linked lists (reversal of linked list, merging two sorted linked lists, detecting loop in linked list, finding middle element), linked list implementation of stacks and queues.

Number of Hours: 8

Module-3

Trees and Hashing: Preliminaries of trees, binary tree, tree traversals, binary search trees and operations, AVL tree algorithm, B- tree and its variations, hashing ADT, hash functions, collision resolution techniques, separate chaining, open addressing, rehashing.

Number of Hours: 8

Module-4

Graph Algorithms: Representation of graphs, breadth first search (BFS), depth first search (DFS), topological sorting, shortest path problems- Dijkstra's algorithm & Bellman Ford algoritm, Greedy algorithm, Branch and bound algorithm, minimum spanning trees, Prim's algorithm, Kruskal's algorithm

Number of Hours: 8

Module-5

Algorithm Design, Sorting and Searching: Algorithm design paradigms – divide and conquer, binary search as divide and conquer, merge sort, quick sort, sorting algorithms – selection, insertion, merge, quick, heap and radix sort, address calculation, linear search, binary search, basic problem-solving algorithms (finding maximum and minimum, second largest element, frequency counting using arrays), pattern matching.

Number of Hours: 8

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Implementation of Linear Queue Operations
2. Singly Linked List Manipulation and Reversal

3. Doubly linked list creation and manipulation
4. Stack and queue implementation with linked lists
5. Binary Search Tree (BST) Creation and Traversal
6. Implementation of Hashing

1. Conversion from infix to postfix
2. Polynomial arithmetic using linked lists
3. Algorithms on Binary search trees
4. BFS and DFS search with graphs
5. Sorting algorithms – quick sort, merge sort implementation
6. Handling collisions in hashing

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

Text Books:

1. J. P. Tremblay and P. G. Sorenson, "An Introduction to Data Structures with applications", Second Edition, Tata McGraw Hil1,1981
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, PHI, 2009.
3. Richard F. Gilberg, Behrouz A. Forouzan, “Data Structures A Pseudocode Approach with C++”, 2nd Edition, Cengage Learning India Pvt. Ltd. 2008.

Reference Books:

1. M. Tenenbaum and Augestien, “Data Structures using C”, Third Edition, Pearson Education2007.
2. Michael T.Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley-India, 2006.

Web links and Video Lectures (e-Resources):

- DSA Virtual Lab: https://ds1-iiith.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. Project-Based Learning
2. Virtual Labs

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 each from both Part A and Part B.

Rubrics for CIE – 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)

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Procedure (PO1)	Is knowledgeable about all aspects of the program, including execution and analysis of the results.	Is knowledgeable about the theoretical concepts and the procedure for execution of the program	Knows the Program, but is not knowledgeable about the theoretical concepts.	Is partially aware of the program, but is not capable of execution.	Is not aware of the procedure of the program.
Conduction (PO3 & PO5)	Executes the program and able to produce the required results and also modified setup for different input cases.	Executes the Program and able to produce the required results.	Executes the program, but not able to generate the required results.	Executes the program in an erroneous manner.	Unable to setup the program.

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.	Micro Project	25
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://nptel.ac.in/courses/106102064	25

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).

BIOMECHANICS			
Course Code	1BBM403	Scheme	2025
Type of Course	Theory	Semester	4
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Analyze Cellular Biomechanics Pathways
2. Model Hemodynamic Flow and Circulatory Cardiovascular Mechanics
3. Evaluate Ocular Bio-Fluid Dynamics and Respiratory Breathing Mechanics
4. Analyze Musculoskeletal Mechanics, Fracture Failures, and Gait Profiles

Module-1

Introduction: A brief history of biomechanics

Cellular Biomechanics: Eukaryotic cellular architecture, Cytoskeleton, Mechanical properties of cells and biomolecules, Models of cellular biomechanics, Mechanotransduction

Number of Hours: 8

Module-2

Hemodynamics: Blood rheology: Blood composition, Large artery hemodynamics: flow patterns in vivo

The circulatory system: Anatomy of the vasculature, The heart: Gross anatomy of the heart Qualitative description of cardiac pumping Cardiac pumping power and ventricular function, The capillaries, The veins

Number of Hours: 8

Module-3

Ocular biomechanics: Ocular anatomy, Biomechanics of glaucoma, Tonometry, Drainage of aqueous humor in normal and glaucomatous eyes, Aqueous humor circulation in the anterior chamber, Optic nerve head biomechanics, Ocular blood flow

The respiratory system: Gross anatomy, The conducting airways and pulmonary vasculature, Associated structures, Biomechanics of breathing, Lung elasticity and surface tension effects

Number of Hours: 8

Module-4

Muscles and movement: Skeletal muscle morphology and physiology, Isotonic versus isometric contraction, Muscle constitutive modelling, Whole muscle mechanics, Parallel versus pinnate muscle types, Muscle/bone interactions , Foreleg motion

Skeletal biomechanics: Introduction to bone, Composition and structure of bone, Cortical bone, Trabecular bone,

Biomechanical properties of cortical and trabecular bone, Cortical bone mechanics, Trabecular bone mechanics, Trabecular bone mechanics: density dependence, Trabecular bone mechanics: unit cell models, Bone fracture and failure mechanics, Fast fracture, Fatigue fracture

Number of Hours: 8

Module-5

Terrestrial locomotion: Jumping, Standing jump, Running jumps, Description of walking and running, Walking, Running, Gait analysis, Kinematics, Anthropometry, Kinetics

Number of Hours: 8

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

Text books:

1. C. Ross Ethier and Craig A. Simmons, Introductory Biomechanics: from Cells and Organisms, Cambridge University Press, 2007

Reference books / Manuals:

1. S. A. Berger, W. Goldsmith, and E. R. Lewis (Ed.), Introduction to Bioengineering, Chapter 1: Biomechanics of Solids, Oxford University Press, Oxford, 1996.
2. D. Boal, Mechanics of the Cell, Cambridge University Press, Cambridge, 2001.
3. P. Nelson, Biological Physics, W. H. Freeman & Company, 2007.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=fCqKhggM120

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. Partial Delivery by medical professionals
2. Case-based teaching

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.	Case study presentation	15
2.	Assignment	10

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

Learning Activity: Case Study Presentation					
Case Study Presentation	Superior	Good	Fair	Needs Improvement	Unacceptable
Clarity of Explanation PO 1, 2, 3	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

Learning Activity: Assignment					
Assignment	Superior	Good	Fair	Needs Improvement	Unacceptable
Clarity of Explanation PO 1, 2, 3	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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

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.	Assignment	10
2.	Seminar	10

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

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_bt04	30

Continuous Internal Evaluation (CIE)

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

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

Passing requirement in SEE

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

EMBEDDED CONTROLLERS			
Course Code	1BBM404	Scheme	2025
Type of Course	Theory	Semester	4
Teaching Hours/Week (L:T:P)	3: 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Analyze Microprocessor and 8051 Microcontroller Architectures
2. Develop Assembly Language Programs for Data Processing and Basic I/O
3. Design Embedded C Programs and Peripheral Interfacing Networks
4. Program Timers, Serial Port Communication, Interrupts, and Advanced low-power Architectures

Module-1

Microprocessor and Microcontroller: Microprocessor survey, RISC and CISC, CPU Architecture, Harvard and VonNeumann, CPU Architecture. 8051 Microcontroller Architecture. Pin functions organizations Input/ Output pins, ports and circuits. Internal and External memory Architecture. 8051 Reg. banks and stack, 8051 flag bits and PSW Register. Special function Registers. Timer /Counter, Serial data input/ output, Interrupts, program counter and ROM space in the 8051

Number of Hours: 8

Module-2

8051 Microcontroller Instruction Set: Immediate and Register addressing modes. Accessing memory using various addressing modes. Bit addressing for I/o and RAM 8051 data types and directives. Jump Loop and CALL Instructions Arithmetic and Logic Instructions and programming I/o port programming. Assembly Language programs using various Instructions.

Number of Hours: 8

Module-3

8051 programming in C and interfacing: Data types and time delay in 8051 C, I/o programming, Logic operation, data conversion programs, accessing Code ROM Space, data serialization. 8051 interfacing to LCD and key board, DAC, stepper motor, DC Motor, Parallel and serial ADC. Elevator.

Number of Hours: 8

Module-4

Timer/ Counter, Serial communication and Interrupts in 8051: Programming 8051 timer/ counter, programming timer 0 and 1 in 8051 C, Basics of serial communication, 8051 connections to RS-232. 8051 serial port programming in assembly and C. 8051 Interrupts, Programming Timer Interrupts, External hardware Interrupts and serial communication Interrupts. Interrupts priority & Interrupt programming in C

Number of Hours: 8

Module-5

Introduction to Advanced Microcontrollers: Salient Features of Advanced Microcontrollers. MSP430F2013 Architecture and pin functions, Memory, Clock Generator, CPU Registers, Addressing modes, Instruction set and emulated Instruction set. Development Environment. Aspects of C for embedded system, Introduction to MSP 430 starter kit, parallel ports

Number of Hours: 8

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

Text books:

2. "The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
3. "MSP430 Microcontroller Basics" John H. Davis, , Elsevier 2010.
4. "Embedded Systems Design using the TI MSP430 series", Cris Nagy, Newnes, Elsevier.

Reference books / Manuals:

4. "The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005.
5. "The 8051 Microcontroller: Hardware, Software and Applications" V. Udhayashankara and MallikarjunaSwamy ,TMH., 2009.

Web links and Video Lectures (e-Resources):

- https://www.udemy.com/course/microcontrollers-iot-learn-with-real-online-hardware/?couponCode=MT260601G1

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. Simulation and Virtual Labs
2. Micro-projects

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.	Course Project	15
2.	Assignment	10

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

Learning Activity: Course Project					
Project Rubrics	Superior	Good	Fair	Needs Improvement	Unacceptable
Project Description (PO1, PO2, PO3, PO9, PO11)	Project is fully complete, highly comprehensive, and introduces innovative ideas	Project fulfills all requirements and includes additional features,	Project successfully meets all primary requirements and functions as expected	Project is partially complete but misses several major requirements	Misses almost all major requirements of the course
Completion Levels (PO4. PO5 PO9, PO11)	Additional innovative features are implemented in addition to the regular tasks	Work includes additional features that enhance the quality	Work is complete and can produce the required results	Work is complete but results are not correct	work is of very poor quality. It contains errors
Documentation (PO9, PO10, PO11)	Complete project report along with detailed discussion and scope for future work	Complete project report including suitable graphical and other elements	Basic project report is available	Documentation is not professional	No documentation available

Learning Activity: Assignment					
Assignment	Superior	Good	Fair	Needs Improvement	Unacceptable
Clarity of Explanation PO 1, 2, 3	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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.	Micro project	20

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

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Self Learning	28

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

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

DATA ACQUISITION CIRCUITS LAB			
Course Code	1BBML405	Scheme	2025
Type of Course	Laboratory	Semester	4
Teaching Hours/Week (L :T : P)	0 : 0 : 2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0 : 0 : 28: 0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Evaluate characteristics of Operational amplifiers
2. Synthesis of Timing, and Waveform Generation Networks
3. Implement of Mixed-Signal Converters

SET OF EXPERIMENTS

1. **Design and test an Inverting and Non-Inverting Amplifier.**
2. Design specific test circuits to measure and evaluate core DC and AC characteristics of an Operational Amplifier.
3. Design Integrator and Differentiator circuit using an Operational Amplifier.
4. Design an Inverting Schmitt Trigger (Regenerative Comparator) circuit using an Operational Amplifier.
5. Design a functional waveform generator kit using two operational amplifiers that simultaneously generates synchronized Square waves
6. Design a Wien bridge oscillator using Operational amplifier
7. Design and set up astable multivibrator using IC 555
8. Design monostable and bistable multivibrators using IC 555
9. Construct a circuit to study the operation of NE565 PLL and to use it as frequency multiplier.
10. Realize the frequency multiplication using NE/ SE 565 PLL IC.
11. Design of Discrete R-2R Ladder and Monolithic Integrated DACs (DAC0800)
12. Construction of a Flash ADC and Evaluation of Integrated Successive Approximation ADC (ADC0809)

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

Text books:

1. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5)
2. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3)
3. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5)

Reference books / Manuals:

1. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin &Fred. F. Driscoll, PHI/Pearson, 2006
2. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001
3. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

Web links and Video Lectures (e-Resources):
• Virtual Lab: http://vlabs.iitkgp.ac.in/aec/
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. Microproject 2. Virtual Labs

Assessment Structure:

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

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

Rubrics for CIE – Continuous assessment:

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)

Rubrics for SEE / CIE Test:

	Superior	Good	Fair	Needs Improvement	Unacceptable
Procedure (PO1)	Is knowledgeable about all aspects of the experiment, including conducting and analysis of the results.	Is knowledgeable about the theoretical concepts and the procedure for conduction of the experiment.	Knows the procedure, but is not knowledgeable about the theoretical concepts.	Is partially aware of the procedure, but is not capable of conduction.	Is not aware of the procedure of the experiment.
Conduction (PO3 & PO5)	Conducts the experiment and able to produce the required results and also modified setup for different input cases.	Conducts the experiments and able to produce the required results.	Conducts the experiment, but not able to generate the required results.	Conducts the experiment in an erroneous manner.	Unable to setup the experiment.

- 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**.

EMBEDDED CONTROLLERS LAB			
Course Code	1BBML406	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	3
Teaching Hours/Week (L :T : P)	0 : 0 : 28	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0 : 0 : 28: 0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	3

Course outcome (Course Skill Set)

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

1. Get hands-on exposure in 8051 and MSP 430 platform.
2. Enhance programming skills using Assembly language and C.
3. Design and interfacing of microcontroller based embedded systems.

SET OF EXPERIMENTS

1. Program using 8051 in Block, Move, Exchange.
2. Program in sorting, finding largest and smallest element in an array.
3. Counters ---> For Hex and BCD up/ down count.
4. Boolean and Logical Instructions. (Bit Manipulation).
5. Subroutines using CALL and RETURN instructions.
6. Code Conversions ---> ASCII to Decimal, Decimal to ASCII, BCD to ASCII.
7. Programs to generate delay, programs using serial port and on chip timer/counter.
8. Assembly program using MSP 430 for data transfer, Block Move in an array
9. Stepper motor Interface to 8051 Microcontroller with C Program.
10. DC Motor Interface to 8051 Microcontroller with C Program
11. DAC Interface for to generate sine wave, square wave, triangular wave, Ramp wave through 8051Microcontroller with C Program.
12. Keyboard Interfacing.
13. ADC Interfacing

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

Text books:

1. "The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad AliMazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. "MSP430 Microcontroller Basics" John H. Davis, Elsevier 2010.
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Web links and Video Lectures (e-Resources):

- https://www.udemy.com/course/microcontrollers-iot-learn-with-real-online-hardware/?couponCode=MT260601G1

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. Microproject
2. Virtual Labs

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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Rubrics for CIE				
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	Superior	Good	Fair	Needs Improvement	Unacceptable
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Conduction (PO3 & PO5)	Conducts the experiment and able to produce the required results and also modified setup for different input cases.	Conducts the experiments and able to produce the required results.	Conducts the experiment, but not able to generate the required results.	Conducts the experiment in an erroneous manner.	Unable to setup the experiment.

- 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**.

BIOLOGY FOR ENGINEERS		Semester	IV
Course Code	**1BBM407**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	02	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of biodesign principles to create novel devices and structures.
- To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
- To motivate the students to develop interdisciplinary vision of biological engineering.

Teaching-Learning Process (General Instructions)

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

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

Module-1 (8 Hours)

INTRODUCTION TO BIOLOGY:

The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each),Properties and functions), vitamins and hormones.

Module-2(8 Hours)

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE):

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

Module-3(8 Hours)

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE):

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

Module-4 (8 Hours)

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE):

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Module-5(8 Hours)

TRENDS IN BIOENGINEERING (QUALITATIVE):

Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead,
Cadmium, Mercury, Arsenic).

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

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

Web links and Video Lectures (e-Resources):

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

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

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

ENVIRONMENTAL SCIENCE PROJECT			
Course Code	**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. It focuses on real issues such as climate change, pollution, biodiversity, resource use, soil erosion, and thermal comfort, using field surveys, case studies, data collection, audits, and analysis to develop feasible and sustainable solutions. Students may work individually or in groups of up to four, including interdisciplinary topics, and assessment is based on the prescribed rubrics.

Course outcome (Course Skill Set):

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

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

Restrictions and professional conduct:

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

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

Methods for project identification:

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

List of Project Topics and Engineering Outcomes:

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

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12

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

16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, 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 totalling 50 marks:

CIE pass requirement:

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

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

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

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

SEE pass requirement and overall passing rule:

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

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

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

Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

Notes for CIE rubric:

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

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

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environment	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of 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.

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

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

Water-quality parameters and	20	Correctly analyzes key physical,	Analyzes most parameters	Some parameters	Minimal or incorrect

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

CONTROL SYSTEMS ENGINEERING			
Course Code	1BBM409	Scheme	2025
Type of Course	PCC	Semester	4
Teaching Hours/Week (L:T:P)	3 : 0 : 0	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	42 : 0 : 0 : 48	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

1. Explain the construction and working principles of Biomedical Transducers.
2. Choose Appropriate Transducers for Biological Signal Acquisition
3. Evaluate the performance of various Biomedical Transducers

Module-1

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems -Mechanical Systems, Electrical Systems, Analogous Systems.

Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.

Number of Hours: 8

Module-2

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers

Number of Hours: 8

Module-3

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion.

Introduction to Root-Locus Techniques: The root locus concepts, Construction of root loci.

Number of Hours: 8

Module-4

Frequency domain analysis and stability: Correlation between time and frequency response, Polar plots, Bode Plots, Experimental determination of transfer function. Mathematical preliminaries, Nyquist Stability criterion

Number of Hours: 8

Module-5

State Variable Analysis: Introduction to state variable analysis: Concepts of state, state variable and state models. State model for Linear continuous -Time systems, solution of state equations

Text books:

1. Control Systems Engineering, I J Nagrath, M. Gopal, New age international Publishers, Fifth edition.

Reference books / Manuals:

1. Modern control engineering., Ogata, K. (2010). Prentice hall.
2. Control system fundamentals. Levine, William S. CRC press, 2019.

Web links and Video Lectures (e-Resources):

- Control Systems: https://nptel.ac.in/courses/107106081

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. Periodic Guest Lectures by Industry Professionals

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.	Tool/Software Exploration	15
2	Assignment (at RBL3, RBL4, or RBL5 levels)	10

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

Learning Activity: Tool/Software Exploration					
Programming Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Operational Familiarity **PO 1, 5**	Completely fluent with all capabilities of the tool and to run simple and complex cases.	Tool is functional with examples, and is able to execute the examples.	Tool is partially functional for examples provided	Tool properly installed and running, but not able to run examples.	Not able to initiate the tool.
Functional Application **PO 1, 3, 4, 5**	Can create complex cases and is capable of debugging to produce the required outputs.	Can create moderately complex examples and simulate with the tool to produce the required outputs.	Can apply the tool to run simple examples and produce the output.	Can create partial examples and run on the tool.	Cannot use the tool.

Learning Activity: Assignment					
Assignment	**Superior**	**Good**	**Fair**	**Needs Improvement**	**Unacceptable**
Clarity of Explanation **PO 1, 2, 3**	Well-organized with proper justification of material and inclusion of suitable materials for explanation of content.	Well-organized with proper justification of material.	Complete explanation of content is available.	Organization of content is not proper.	Explanations are not available.

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.	Micro project	12
2.	Assignment	12

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

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	https://nptel.ac.in/courses/107106081	24

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).