Ref: MITM/ECE/CBS/2023-24/001

MAHARAJA INSTITUTE OF TECHNOLOGY MYSORE

Autonomous Institution Affiliated to VTU

Competency Based Syllabus (CBS)
for

Electronics and Communication Engineering

(Under Outcome Based Education (OBE) and

Choice-Based Credit System (CBCS))

Offered from 3rd to 4th Semesters of Study
in

Partial Fulfillment for the Award of Bachelor's Degree in

Electronics and Communication Engineering

2023 Scheme

Scheme Effective from the academic year 2023-24

General Contents of Competency Based Syllabus Document

Index	Description
1	Prerequisites
2	Competencies
3	Syllabus
4	Syllabus Timeline
5	Teaching-Learning Process Strategies
6	Assessment Details
7	Learning Objectives
8	Course Outcomes and Mapping with POs/ PSOs
9	Assessment Plan
10	Future with this Subject

3rd Semester	Basic Science Course (BS) MATHEMATICS-III FOR ECE STREAM	M23BMATE301

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic concepts of Statistic and Curve fitting	Understanding the relationship between one or more predictors and a response variable to define a "best fit" model of the relationship Familiarity with fundamental knowledge of algebra course
2.	Calculus	Knowledge of calculus, specifically integration and differentiation, and an understanding of complex numbers
3.	Basic Concepts of Linear Algebra	Strong knowledge of calculus, linear algebra, complex numbers, and trigonometric function
4.	Basic Mathematics	Knowledge of advanced calculus, linear algebra, and ordinary differential equations Familiarity with identifying the dependent and independent variables
5.	Basic Concept of Permutation and Combination	Knowledge of basic set theory, inclusion and exclusion principle (knowing different ways of counting), and calculus(knowing derivatives and integrals)
6.	Previous Coursework	Completion of introductory courses in Mathematics or a related field.

2. Competencies

S/L	Competency	KSA Description
1	Statistical Methods	**Knowledge:** Principle of least squares, Correlations, and lines of regressions **Skills:** Apply correlation analysis to build more accurate and efficient models **Attitudes:** Appreciation for the correlation analysis to build more accurate and efficient models
2	Probability Distribution	**Knowledge:** Understanding of Poisson and Normal Distribution **Skills:** Apply probability for risk assessment in the design of structures such as bridges, Dams, and buildings **Attitudes**: Appreciation for the role of Probability distribution in risk assessment.
3	Fourier Series	**Knowledge:** Periodic functions, Dirichlet's condition, Practical harmonic analysis **Skills:** Fourier series to represent periodical physical phenomena in Engineering analysis. **Attitudes:** Appreciation for the role of Fourier series engineering
4	Fourier transform and Z-transform	**Knowledge:** Fourier Transforms, Z transforms, Damping rule **Skills:** Apply Z -Transform to analyze and process digital data and analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations **Attitudes:** Appreciation for the role of Fourier Transform and Z-Transform analyze problems involving continuous-time signals
5	Ordinary Differential Equations of Higher Order	**Knowledge:** Ordinary Differential Equations of first and higher order **Skills:** Solving ordinary and partial differential equations arising in L-C Circuits and L-C-R circuit **Attitudes:** Appreciation for the role of ODE in calculating the movement or flow of electricity, the motion of an object to and fro like a pendulum, to explain thermos dynamics concepts

6	Curve Fitting	**Knowledge:** Principle of least squares, Correlations, and lines of regressions **Skills:** Apply correlation analysis to build more accurate and efficient models. **Attitudes:** Appreciation for using the principle of least square to get the best fitting of a curve like a straight line, second-degree parabola

3. Syllabus

MATHEMATICS-III FOR ECE STREAM SEMESTER – III			
Course Code	**M23BMATE301**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P:S)	**(2:2:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

1. Appreciate the importance of Statistical methods, Probability, Series, and Numerical techniques in Engineering problems.
2. Acquire the knowledge of Statistical methods, Probability, Series, and Numerical techniques to apply them in their core domain.
3. Improve their Mathematical thinking and acquire skills required for sustained lifelong learning.
4. Develop the knowledge of solving differential equations and their applications in Electronics & Communication engineering.

Module -1 Statistical Methods and Curve Fitting	
Curve fitting by the method of least squares, fitting the curve of the forms $y = ax + b$, $y = ax^b$ and $y = ax^2 + bx + c$ Correlation and regression- Karl Pearson's coefficient of correlation and rank correlation, problems. Regression analysis, lines of regression, problems	L1, L2,L3
Module -2 Probability Distribution	
Review of basic probability theory. Random variables (discrete and continuous), probability Mass, and density functions. Mathematical expectation, mean, and variance. Binomial, Poisson Exponential, and Normal Distributions, (Statement only), Problems Joint probability distribution: Joint Probability distribution for two discrete random variables, Expectation, covariance, and correlation.	L1, L2,L3
Module -3 Fourier Series	
Introduction to trigonometric polynomial, trigonometric series. Dirichlet's conditions. Fourier series of periodic functions with period $2l$. Practical harmonic analysis.	L1, L2, L3
Module -4: Infinite Fourier Transforms and Z-Transforms	
Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms Inverse Fourier cosine and sine transforms, FFT -Problems. Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations	L1, L2,L3
Module -5 Ordinary Differential Equations of Higher Order	
Higher-order linear ODEs with constant coefficients - Inverse differential operator, problems. Linear differential equations with variable Coefficients-Cauchy's and Legendre's Differential equations–Problems. Application of linear differential equations to L-C circuit and L-C-R circuit.	L1, L2,L3

Text Books:

1. B.S. Grewal: "Higher Engineering Mathematics", Khanna publishers,44thEd.2018
2. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons,10th Ed.(Reprint), 20

Reference Books:

1. V.Ramana: "Higher Engineering Mathematics" McGraw-HillEducation,11thEd.
2. Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics" Oxford University Press, 3rd Reprint,2016.
3. N.P Bali and Manish Goyal: "A text book of Engineering Mathematics" Laxmi Publications, Latest edition.
4. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw– HillBook Co. Newyork, Latest.
5. Gupta C. B, Sing S.R and Mukesh Kumar: "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education (India) Pvt. Ltd 2015.
6. H.K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics" S.Chand Publication (2014).James Stewart: "Calculus" Cengage publications, 7th edition, 4th Reprint2019.

4. Syllabus Timeline

S/L	Syllabus Timeline (No. of weeks should be as you have in the semester)	Description
1	Week 1-2: Statistical Methods and Curve Fitting	Correlation and regression Karl Pearson's coefficient of correlation and rank correlation Worked Problems Regression analysis, lines of regression Worked Problems Fitting the curve of the forms $y = ax + b$ Fitting the curve of the forms $y = ax^b$ Fitting the curve of the forms $y = ax^2 + bx + c$
2	Week 3-4: Probability Distribution	Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions Problems on Binomial Distribution Problems on Poisson Distribution Problems on Exponential Distribution Problems on Normal Distribution Joint Probability distribution for two discrete random variables Worked Problems
3	Week 5-6: Fourier Series	Introduction to trigonometric polynomial, trigonometric series. Dirichlet's conditions Fourier Series of periodic functions with period2l Worked Problems Fourier Series of periodic tasks with period2π Worked Problems Practical harmonic analysis. Worked Problems
4	Week 7-8: Fourier Transforms and Z-Transforms	Infinite Fourier transforms definition Fourier sine and cosine transforms Inverse Fourier transforms & Inverse Fourier cosine and sine transforms FFT –Problems, Difference equations, z-transform-definition, Standard z-transforms Damping and shifting rules, Problems Inverse z-transform and applications to solve difference equations, Worked Problems
5	Week 9-10: Ordinary Differential Equations of Higher Order	Higher-order linear ODEs with constant coefficients Inverse differential operator, problems. Worked Problems Linear differential equations with variable Coefficients-Cauchy's DE Worked Problems Linear differential equations with variable Coefficients- Legendre's DE Application of linear differential equations to L-C circuit Application of linear differential equations to L-C –R circuit
6	Week 11-12: Integration and Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture for matto reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding.
3	Collaborative Learning	Encourage collaborative learning for improved competency Application.
4	Higher Order Thinking(HOTS)	Pose HOTS Questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning(PBL)	Implement PBL to enhance analytical skills and practical application of Competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discusspracticalapplicationstoconnecttheoreticalconceptswithreal-world competencies.
8	Flipped Class Technique	Utilize a flip ped class approach, providing materials before class to facilitate Deeper understanding of competencies
9	Programming Assignments	Assign programming task store in force practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE) Note:

40% of the maximum marks (100). A student shall be deemed to have satisfied the academic. Requirements if the student secures not less than 40% (40 Marks out of 100) in the CIE.

Continuous Internal Evaluation:

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

The average internal assessment shall be the average of the 2 test marks conducted.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Transforms and its Fundamentals	Students will learn Use Fourier transform and Z- transform and inverse Z transforms in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
2	Understanding Fundamentals of Statistics	Students will formulate complete, concise, and correct mathematical proofs. Students will frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques
3	Proficiency in Fourier series	Students will become proficient in writing a series expansion of even and odd function and also writing the best fitting of the curve using the least square method
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs /PSOs Course Outcomes (COs)

COs	Description
M23BMATM301.1	Apply the concepts of Statistics, Probability, ordinary differential equation, series and transforms to solve Engineering Problems
M23BMATM301.2	Analyze the electronics engineering problems through z-transforms and series method
M23BMATM301.3	Relate the importance of transformation and series appearing in electronics engineering

CO-PO-PSO Mapping

COs/PO s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BMATM301.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BMATM301.2		3	-	-	-	-	-	-	-	-	-	-	-	-
M23BMATM301.3	3		-	-	-	-	-	-	-	-	-	-	-	-
M23BMATM301	3	3	-	-	-	-	-	-	-	-	-	-	-	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Module 1	2	5	3	10
Module 2	2	5	3	10
Module 3	2	5	3	10
Module 4	2	5	3	10
Module 5	2	5	3	10

Total	10	25	15	50

Semester End Examination (SEE)

	CO1	CO2	CO3	**Total**
Module 1	4	10	6	20
Module 2	4	10	6	20
Module 3	4	10	6	20
Module 4	4	10	6	20
Module 5	4	10	6	20
Total	20	50	30	100

10. Future with this Subject

The "Mathematics-III for ECE Stream" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

Linear and Nonlinear Regression: The knowledge gained in this course, regression analysis, curve fitting is the process of specifying the model that provides the best fit to the specific curves in your dataset. Curved relationships between variables are not as straightforward to fit and interpret as linear relationships. For linear relationships, as you increase the independent variable by one unit, the mean of the dependent variable always changes by a specific amount. This relationship holds true regardless of where you are in the observation space.

Mathematical Finance: Probability as a subject in and of itself has rarely been truly appreciated by mathematicians in other disciplines. This has gradually changed over the last 50 years, as occasionally brilliant mathematician's show how it can be used to solve, or to explain, and/or to give intuitive content to thorny mathematical issues. We provide some examples and then give a wild speculation as to where the field, at least in Mathematical Finance, might go in the future.

Control Theory Control theory for partial differential equations (PDEs) deals with the use of inputs to influence the behavior of a system governed by PDEs, to achieve a desired goal. This program is focused on recent outstanding developments on controllability and stabilizability of parabolic, hyperbolic and dispersive PDEs. These PDEs appear naturally as mathematical models in numerous applications in physics, engineering, biology, and medicine. Depending on the type of PDEs, the control aspects of PDEs and the techniques used to study them change significantly.

3rd Semester	Professional Core Course (PC) NETWORK ANALYSIS	M23BEC302

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Physics	Knowledge of basic circuit laws such as Ohm's law, KCL, KVL and its applications to simple resistive circuits. Simplification of Circuit connections.
2	Mathematics	Application of Differential calculus, Integral calculus and Laplace transformation to electrical circuits.
3	Basic electrical engineering	Fundamental knowledge of single phase AC circuits.

2. Competencies

S/L	Competency	KSA Description
1	Simplification of the circuits	**Knowledge:** Voltage, current, resistance, power, energy, Ohm's Law. **Skills:** Ability to simplify the complex networks. **Attitudes:** Analysis and problem-solving. Approach problems methodically, breaking them down into parts
2	Apply KVL & KCL to solve electrical networks	**Knowledge:** Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), mesh analysis, nodal analysis. **Skills:** Analyzing and solving circuits using systematic methods. **Attitudes:** Critical thinking**,** Analysis, applying and problem-solving
3	Apply concepts of network theorems to obtain solutions for complex electrical network	**Knowledge:** Thevenin's & Norton's theorems, superposition theorem, Maximum Power Transfer theorem and Millman's theorem. **Skills:** Simplifying complex circuits using network theorems. **Attitudes:** Analysis, applying and problem-solving
4	Analyse the circuits with variable frequency and variable circuit elements.	**Knowledge:** Phasor, impedance, reactance, AC power analysis, resonance, frequency response. **Skills:** Analyzing AC circuits and understanding their behavior over different frequencies. **Attitudes:** Critical thinking**,** Analysis, applying and problem-solving
5	Analysis of circuits during switching operations.	**Knowledge:** Time constants, transient response of RL, RC, and RLC circuits. **Skills:** Solving differential equations related to circuit transients and understanding system response over time. **Attitudes:** Analysis, applying and problem-solving

3. Syllabus

NETWORK ANALYSIS SEMESTER – III			
Course Code	**M23BEC302**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**2:2:0**	SEE Marks	**50**
Total Hours of Pedagogy	**40**	Total Marks	**100**
Credits	**03**	Exam Hours	**3**
Examination type (SEE)	**Theory**		

Course objectives:

1. Apply mesh and nodal techniques to solve an electrical network.
2. Solve different problems related to Electrical circuits using Network Theorems and Two port network.
3. Familiarize with the use of Laplace transforms to solve network problems.
4. Study two port network parameters and their applications.
5. Study of RLC Series and parallel tuned circuit.

Teaching-Learning Process (General Instructions)

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

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Encourage collaborative (Group)Learning in the class.
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.

➢ Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it. ➢ Topics will be introduced in a multiple representation. ➢ Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them. ➢ Discuss how every concept can be applied to the real world-and when that's possible, it helps improve the student's understanding. ➢ Adopt Flipped class technique by sharing the materials/Sample Videos prior to the class and have discussions on the topic in the succeeding classes.	
Module -1	
Basic Concepts: Practical sources, Source transformations, Network reduction using Star-Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks.	L1, L2, L3, L4
Module -2	
Network Theorems: Superposition, Millman's theorems, Thevinin's and Norton's theorems, Maximum Power transfer theorem.	L1, L2, L3,L4
Module -3	
Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations.	L1, L2, L3, L4
Module -4	
Laplace Transformation & Applications: Solution of networks, step, ramp, and impulse responses, Initial & Final value theorems, and waveform Synthesis.	L1, L2, L3, L4
Module -5	
Two port network parameters: Definition of Z, Y, h and Transmission parameters, modelling with these parameters, relationship between parameters sets. Resonance: Series Resonance: Variation of Current and Voltage with Frequency, Selectivity and Bandwidth, Q-Factor, Circuit Magnification Factor, Selectivity with Variable Capacitance, Selectivity with Variable Inductance. Parallel Resonance: Selectivity and Bandwidth, Maximum Impedance Conditions with C, Land f Variable, current in Anti-Resonant Circuit, The General Case-Resistance Present in both Branches.	L1, L2, L3, L4
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Determine currents and voltages using source transformation/ source shifting/ mesh/ nodal analysis and reduce the given network using star-delta transformation. 2. Solve problems by applying Network Theorems and electrical laws to reduce circuit complexities and arrive at feasible solutions. 3. Analyse the circuit parameters during switching transients and apply the Laplace transform to solve the given network 4. Evaluate the frequency response for resonant circuits and the network parameters for two-port networks	
Text Books: 1. M.E. Van Valkenburg (2000), ―Network analysis, Prentice Hall of India, 3rd edition, 2000, ISBN: 9780136110958. 2. Roy Choudhury, ―Networks and systems, 2nd edition, New Age International Publications, 2006, ISBN: 9788122427677. **Reference Books:** 1. Hayt, Kemmerly and Durbin ―Engineering Circuit Analysis, TMH 7th Edition, 2010. 2. J. David Irwin /R. Mark Nelms―Basic Engineering Circuit Analysis, John Wiley, 8thed, 2006. 3. Charles K Alexander and Mathew N O Sadiku, ― Fundamentals of Electric Circuits, Tata McGraw-Hill, 3rd Ed, 2009.	

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Basic Concepts	Practical sources, Source transformations, Network reduction using Star – Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks. Numerical Problems
2	Week 3-6: Network Theorems	Superposition, Millman's theorems, Thevinin's and Norton's theorems, maximum Power transfer theorem. Statements, explanation and numerical problems of all theorems.

3	Week 6-9: Transient behavior and initial conditions	Behavior of circuit elements under switching condition and their Representation, evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations, Numerical problems
4	Week 9-12: Laplace Transformation & Applications	Solution of networks for step, ramp, and impulse input signals, Initial & Final value theorems, and waveform Synthesis.
5	Week 12-14: Two port network parameters, Resonance	Definition of Z, Y, h and Transmission parameters, modeling with these parameters, and the relationship between parameter sets. Series Resonance: Variation of Current and Voltage with Frequency, Selectivity and Bandwidth, Q-Factor, Circuit Magnification Factor, Selectivity with Variable Capacitance, Selectivity with Variable Inductance. Parallel Resonance: Selectivity and Bandwidth, Maximum Impedance Conditions with C, Land f Variable, current in Anti-Resonant Circuit, The General Case-Resistance Present in both Branches.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Network concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Assignments	Assignments including more problems will be given to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations (SEE):

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the basic concepts and apply them to solve problems	Apply mesh and nodal techniques to solve an electrical network.
2	Apply network theorems to the electrical network	Solve different problems related to Electrical circuits using Network Theorems and the Two port network
3	Analyze the transient behavior of the network	Familiarize with the use of Laplace transforms to solve network problems.
4	Apply two port network concepts to the electrical network	Study two-port network parameters and their applications.
5	Analyze the resonant condition of a circuit	Study of RLC Series and parallel tuned circuit.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC302.1	Apply the source transformation technique, source shifting technique, star delta transformation & electrical laws to solve electrical networks.
M23BEC302.2	Apply the concept of network theorems to solve the complex electric circuits.
M23BEC302.3	Analyze the transient behavior and the resonant condition of the network based on the electrical parameters and frequency.
M23BEC302.4	Analyze electrical circuits and synthesize waveforms using Laplace transformation.
M23BEC302.5	Apply the concept of two port network parameter and their relationship to solve the electrical network.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC302.1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC302.2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC302.3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC302.4	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC302.5	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC302	3	3	-	-	-	-	-	-	-	-	-	-	2	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**

Module 1	**10**					**10**
Module 2		**10**				**10**
Module 3			**10**			**10**
Module 4				**10**		**10**
Module 5					**10**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**20**					**20**
Module 2		**20**				**20**
Module 3			**20**			**20**
Module 4				**20**		**20**
Module 5					**20**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

10. Future with this Subject

The "Network Analysis" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of circuit theory. Here are some notable contributions:

1. Analog Electronics: Network Analysis principles are used extensively in designing analog electronic circuits such as amplifiers, filters, oscillators, and signal conditioning circuits. Understanding concepts like Ohm's law, Kirchhoff's laws, and network theorems helps engineers design circuits that process and manipulate continuous signals efficiently.
2. Digital Electronics: In digital electronics, Network Analysis is employed to design logic gates, flip-flops, registers, and other digital components. Boolean algebra and Karnaugh maps, derived from circuit theory, are essential tools for simplifying logic expressions and optimizing digital circuits for performance and power efficiency.
3. VLSI Design: Integrated circuits (ICs) are built using millions of interconnected electronic components on a tiny semiconductor chip. Network Analysis principles guide the design and layout of these components to ensure proper functionality, performance, and reliability.
4. Power Electronics: Power electronic circuits control and convert electrical power efficiently. Network Analysis is used to design power converters, inverters, rectifiers, and motor drives, applying concepts such as power dissipation, voltage regulation, and current limiting.
5. Communication Systems: Network Analysis is fundamental to understanding the behaviour of communication systems. It is applied in the design of modulators, demodulators, filters, amplifiers, and other components used in transmitting, receiving, and processing signals in communication networks.
6. RF and Microwave Engineering: In RF (Radio Frequency) and microwave systems, Network Analysis principles are applied to design circuits operating at high frequencies. This includes transmission lines, impedance matching networks, microwave filters, and RF amplifiers used in wireless communication systems, radar systems, and satellite communication.
7. Control Systems: Network Analysis is used in analyzing and designing control systems for regulating the behaviour of dynamic systems. Techniques such as transfer functions, Laplace transforms, and frequency domain analysis are applied to model and analyze the control loops in various electronic and communication systems.

3rd Semester	Professional Core Course (PC) ANALOG ELECTRONIC CIRCUIT DESIGN	M23BEC303

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Analog components	• Understanding of active and passive components. • Familiarity with fundamentals of discrete components and color codes of resistors, capacitors, inductors and diode, etc. Transistor, operational amplifiers and timer circuits.
2.	Electronic Circuits	• Knowledge of basic electronic components and circuits. • Understanding voltage, current, and characteristic behaviour in electronic circuits.
3.	Mathematics	• Proficiency in algebra for solving few mathematical expressions using voltage divider rule, integration, and differential equations to calculate the desired voltage, and frequency of operation.
4.	Basic Understanding of Analog circuit	• Knowledge of basic analog designing (BJT and MOSFET and their configurations, etc.). • Understanding of Op-amp Circuits.
5.	Fundamental Electronics Knowledge	• Knowledge of basic analog circuits (Voltage Amplifiers, Power amplifiers, Oscillators, etc.)
6.	Previous Coursework	• Completion of introductory courses in Basic electronics

2. Competencies

S/L	Competency	KSA Description
1.	Diode Applications	**Knowledge:** • Understanding the operation of diodes for various applications. **Skills:** • Ability to choose the type of diode for a specific application. **Attitudes:** • Appreciation for knowing the biasing details of a diode for specific applications.
2.	Small signal designing – Amplifier circuits using Transistors	**Knowledge:** • Understanding of transistors and their configurations, Knowledge of designing transistor AC and DC models. **Skills:** • Ability to apply voltage divider rule, ohms-law, KVL, KCL, and Thevenin theorem to design the required analog circuit for small signals using a transistor. • Proficiency in designing small signal voltage amplifiers using transistors. **Attitudes:** • Appreciation for designing simple voltage amplifiers using transistors for analog models.
3.	Designing LC and RC Oscillators	**Knowledge:** • Understanding of positive feedback and its application in oscillator circuits. **Skills:** • Designing LC and RC oscillators based on specifications. • Analysing and evaluating the performance based on their frequency of application **Attitudes:** • Appreciation for the role of designing basic oscillator circuits for audio and radio frequencies.
4.	Designing of linear operational circuits	**Knowledge:** • Understanding of Opamp and their types, applications as summer, digital to analog converter, active filters **Skills:** • Designing summer circuit, filters (first order and second order filters for VCVS). • Designing HPF, BPF and BRF using Op-amp. **Attitudes:**

		• Valuing the importance of filtering circuits to eliminate noise in any analog system designing
5.	Large signal designing - Transistor	**Knowledge:** • Understanding of power amplifiers and its applications. • Knowledge of designing types of power amplifiers and their applications. **Skills:** • Ability to design class A, class B and class C amplifiers. • Proficiency in designing large signal amplifier using transistors models. **Attitudes:** • Appreciation for designing power amplifiers using transistor for analog models.

3. Syllabus

ANALOG ELECTRONIC CIRCUIT DESIGN SEMESTER – III			
Course Code	**M23BEC303**	**CIE Marks**	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Number of Lecture Hours	**40(T)Hrs**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives: This course will enable students to:
This course will enable students to

- Understand the diodes for practical applications.
- Design and analyze the BJT circuits as an amplifier using small signal equivalent circuit models.
- Design of MOSFET Amplifier and analyze the basic amplifier configurations using small signal equivalent circuit models
- Design of operational amplifier circuits such as Comparators, DAC, and filters.
- Understand the concept of positive and negative feedback.
- Analyze Power amplifier circuits in different modes of operation.
- Construct Feedback and Oscillator circuits.

Module -1	
Diode Applications: Zener diodes, LEDs, AND/OR gates, Clippers, Clampers, Solar cells, Photodiodes, Photo conductive cells, IR emitters.	L1, L2, L3
Module -2	
BJT Biasing: Introduction, operating point, Fixed bias configuration, Emitter bias configuration, Voltage Divider Bias configuration, Collector feedback configuration, Emitter follower, Common Base configuration. Enhancement-Type MOSFET Biasing: Drain feedback Biasing, Voltage divider Biasing.	L1, L2,L3
Module -3	
BJT AC analysis: Introduction, amplification in AC domain, BJT transistor modelling, the re transistor model, common emitter fixed bias configuration, Voltage divider bias, Emitter bias configuration, emitter follower configuration, common bias configuration, collector feedback configuration, Collector Dc configuration, Effect of R_L and Rs, determining the current gain. FET Amplifier: JFET AC Equivalent circuit, Enhancement type MOSFETs: Drain feedback configuration, Voltage divider configuration	L1, L2, L3
Module -4	
Power amplifiers: Introduction-Definition and amplifier types, Series-Fed Class A amplifier, Transformer coupled Class A amplifier, Class B amplifier operation, Class B amplifier circuits, Amplifier distortion, Class C and Class D amplifiers. Feedback Amplifiers: Feedback concepts, feedback connection types, practical feedback connections. Oscillators: Oscillator operation, Phase shift oscillator, Tuned oscillator circuit, Crystal Oscillator.	L1, L2, L3
Module -5	
Applications of Op-amp: Inverting and Non inverting Amplifiers – Closed Loop voltage gain, Input impedance, Output impedance, Bandwidth with feedback. DC and AC Amplifiers, Comparators, Zero Crossing Detector, Schmitt trigger. DAC - R-2R ladder, ADC- Successive approximation type, Small Signal half wave rectifier. 555 Timer and its applications: Mono-stable and Astable Multi-vibrators.	L1, L2, L3

Suggested Learning Resources:
Text Books:

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, 11th Edition, Pearson Education, 2013, ISBN: 978-93-325-4260-0.

2. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, 4th Edition. Pearson Education,
2000. ISBN: 8120320581

Reference Boos:

1. Albert Malvino, David J Bates, Electronic Principles, 7th Edition, McGraw Hill Education, 2017, ISBN:978-0-07-063424-4.
2. Microelectronic Circuits, Theory and Applications, Adel S Sedra, Kenneth C Smith, 6thEdition, Oxford, 2015.ISBN:978-0-19-808913-1
3. Electronic Devices and Circuit, Boylestad&Nashelsky, Eleventh Edition, Pearson,January2015.

Web links and Video Lectures(e-Resources):

- https://www.analog.com/en/product-category/rf-amplifiers.html
- https://archive.nptel.ac.in/courses/108/105/108105158/
- https://archive.nptel.ac.in/courses/108/108/108108114/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2:	Some of the main Diode Applications are discussed which include Zener diodes for voltage regulators, LED diodes and Photo diodes as transducers, AND/OR gates for digital circuit design. Further, Clippers and Clampers as wave shaping circuits, Solar cells, Photo conductive cells, IR emitters as transducers and LCD's.
2	Week 3-5:	DC analysis of BJT/ MOSFET Biasing circuits is done in view of their application as an amplifier. The operating point stability is discussed and various biasing circuits such as Fixed bias configuration, Emitter bias configuration, Voltage Divider Bias configuration, Collector feedback configuration are compared. Also, Enhancement-Type MOSFET biasing circuits are analysed.
3	Week 6-7:	BJT/MOSFET AC analysis is discussed in detail along with amplification in AC domain. BJT transistor modelling with respect to re model is analysed for various circuits such as common emitter fixed bias configuration, Voltage divider bias, Emitter bias configuration, emitter follower configuration, common bias configuration, collector feedback configuration and Collector Dc configuration..
4	Week 8-9:	Effect of R_L and Rs, determining the current gain is discussed with the help of relevant equations for BJT amplifier circuits. AC equivalent model for JFET, Enhancement type MOSFETs is also included. Power amplifiers are introduced with Definition and types such Series-Fed Class A amplifier, Transformer coupled Class A amplifier, Class B, class C and amp Class D amplifier circuits.
4	Week 10-11:	Amplifier distortion is also discussed followed by Feedback concepts and topologies with practical feedback connections. Further, Oscillator operation and types such as Phase shift oscillator, Tuned oscillator circuit, Crystal Oscillator are discussed.
6	Week 12-13	Linear and nonlinear applications of Op-amps are discussed in detail. Inverting and Non inverting Amplifiers analysis with respect to the relevant parameters, DC and AC Amplifiers, Comparators, Zero Crossing Detector, Schmitt trigger. DAC - R-2R ladder, ADC- Successive approximation type, Small Signal half wave rectifier are discussed along with 555 Timer and its applications: Monostable and Astable Mult-ivibrators

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	• Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	• Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	• Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	• Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	• Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	• Introduce topics in various representations to reinforce competencies

7	Real-World Application	• Discuss practical applications to connect theoretical concepts with real-world competencies.
9	Programming Assignments	• Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative, and other Assessments shall be conducted as per the Institution's calendar of events in all the courses of the program offered to the students, within the framework of the Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

For a theory course, with an L-T-P distribution of L-0-0, the CIE will carry a maximum of 50% weightage of the total marks of a course.

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

The Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.

2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.

3. The students have to answer 5 full questions selecting one full question from each module.

4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding of diodes applications	This course is intended to develop an understanding applications of diodes
2	Analyse the BJTs / MOSFETs biasing	The course helps to analyse the various biasing techniques used for BJTs & MOSFETs

3	Analyse the BJTs / MOSFETs as amplifiers	The course helps to analyse the operation of BJTs & MOSFETs as small signal amplifier and design using BJT & MOSFETs linear transistor models
4	Analyse the operation of power amplifiers, feedback amplifiers and oscillators.	The course includes understanding of different feedback topologies used in amplifiers and oscillators.
5	Understanding of applications of Op-amps	This course is intended to develop an understanding of applications of Op-amp such as DAC/Filters & 555 Timer

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC303.1	Apply the principles of operation of junction diodes for Zener diodes, LEDs, AND/OR gates, Clippers, Clampers, Solar cells, Photo diodes, Photo conductive cells and IR emitters.
M23BEC303.2	Apply the biasing concepts of BJT / MOSFET for amplifier/oscillator circuits.
M23BEC303.3	Analyze amplifiers/oscillators concerning the relevant parameters.
M23BEC303.4	Analyze OP-AMP circuits according to the applications.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC303.1	2	-	-	-	-	-	-	-	2	2	-	2	3	2
M23BEC303.2	3	3	-	2	-	-	-	-	2	2	-	2	3	2
M23BEC303.3	3	3	-	2	-	-	-	-	2	2	-	2	3	2
M23BEC303.4	3	3	-	2	-	-	-	-	2	2	-	2	3	2
M23BEC303	**2.75**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**2**	**3**	**2**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	3	2	3	2	10
Total	13	12	13	12	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	5	5	5	5	20
Total	25	25	25	25	**100**

10. Future with this Subject

The "Analog Electronic Circuit Design "course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the student's understanding and skills in the field of analog systems. Here are some notable contributions:

- Advanced Analog Design Courses: The knowledge gained in this course, covering principles of linear and integrated and VLSI, serves as a prerequisite for more advanced courses in analog design. Students can delve deeper into topics such as VLSI-based design and ULSI systems.

- Embedded Systems: Understanding LTspice and analog system design is crucial for students pursuing courses related to embedded systems. The ability to model, simulates, and synthesize analog systems using sophisticated tools is directly applicable in the design and implementation of embedded systems.
- VLSI Design: The course provides a solid foundation for students interested in pursuing VLSI (Very Large Scale Integration) design courses. The principles of linear and non-linear devices, along with the skills in using LTspice for simulation and behavioral descriptions, are essential for designing complex integrated circuits.
- Project Work and Research: The hands-on experience gained through simulation design, problem-solving, and project work in analog system design using LTspice prepares students for more extensive projects in their later years. It equips them with the skills needed for research in the field of analog system design.
- Industry Applications: The course provides practical skills that are directly applicable in industries related to analog system design, VLSI, embedded systems, and more. Graduates are well-prepared to contribute to the development of VLSI hardware and systems.

3rd Semester	Integrated Professional Core Course (IPC) DIGITAL SYSTEM DESIGN USING VERILOG	M23BEC304

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Digital Logic	Understanding of Boolean algebra. Familiarity with fundamental digital logic concepts such as gates, flip-flops, and combinational and sequential circuits.
2	Electronic Circuits	Knowledge of basic electronic components and their behavior in electronic circuits.
3	Programming Concepts.	Basic understanding of programming concepts.
4	Basic Understanding of Digital Logic	Knowledge of basic digital logic gates (AND, OR, NOT, etc.). Understanding of Boolean algebra and logic simplification techniques
5	Fundamental Electronics Knowledge	Basic understanding of electronic components, circuits, and their behavior. Knowledge of binary number system and arithmetic.
6	Previous Coursework	Completion of introductory courses in Basic electronics or a related field.

2. Competencies

S/L	Competency	KSA Description
1	Boolean Expression Simplification	**Knowledge:** Understanding of Boolean algebra principles. Knowledge of Karnaugh maps and Quine-McCluskey minimization techniques. **Skills:** Ability to apply K-map techniques for Boolean expression simplification. Proficiency in utilizing Quine-McCluskey minimization techniques. **Attitudes:** Appreciation for the importance of logical simplification in digital system design.
2	Combinational Logic Circuits	**Knowledge:** Understanding of combinational logic principles and canonical forms. **Skills:** Designing combinational logic circuits based on specifications. Analyzing and evaluating the performance of combinational logic circuits. **Attitudes:** Appreciation for the role of combinational logic in digital systems.
3	Sequential Logic Circuits	**Knowledge:** Understanding of flip-flops, registers, and sequential logic principles. **Skills:** Designing sequential logic circuits with flip-flops. Optimizing the behavior of sequential circuits. **Attitudes:** Valuing the importance of sequential logic in digital system functionality
4	Verilog HDL	**Knowledge:** Understanding the structure of Verilog modules. Knowledge of Verilog operators and data types. **Skills:** Applying Verilog for digital system design. Describing digital systems using Verilog data flow and behavioral models. **Attitudes:** Openness to learning and using hardware description languages for design.
5	Logic Design with MSI Components and PLDs	**Knowledge:** Understanding of MSI components and PLDs. **Skills:** Implementing binary adders, subtractors, comparators, and multiplexers. Utilizing programmable logic devices (PLDs) in logic design. **Attitudes:**

		Appreciation for the versatility of MSI components and PLDs in digital logic design.
6	Flip-Flops and its Applications	**Knowledge:** Understanding the characteristics of flip-flops. **Skills:** Designing and analyzing binary ripple counters and synchronous binary counters. Implementing mod-n counters using different flip-flops. **Attitudes:** Recognizing the significance of flip-flops in sequential logic circuits
7	Introduction to Verilog	**Knowledge:** Understanding the structure of Verilog modules. Knowledge of Verilog operators and data types. **Skills:** Applying Verilog for digital system design. Describing digital systems using Verilog data flow and behavioral models. **Attitudes:** Openness to learning and using hardware description languages for design.
8	Verilog Behavioral and Structural Description	**Knowledge:** Understanding of Verilog behavioral and structural description. **Skills:** Writing Verilog behavioral descriptions. Implementing loop statements and structural descriptions in Verilog. **Attitudes:** Appreciation for the role of clear and well-structured Verilog code in design.

3. Syllabus

DIGITAL SYSTEM DESIGN USING VERILOG SEMESTER – III			
Course Code	**M23BEC304**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hr Theory + 10 Lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**
Course objectives: This course will enable students to: • To impart the concepts of simplifying Boolean expression using K-map techniques and Quine- Mc Cluskey minimization techniques. • To impart the concepts of designing and analyzing combinational logic circuits. • To impart design methods and analysis of sequential logic circuits. • To impart the concepts of Verilog HDL-data flow and behavioral models for the design of digital systems.			
Module -1			
Principles of combination logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps- up to 4 variables, Quine-Mc Cluskey Minimization Technique. .			L1, L2, L3
Module -2			
Logic Design with MSI Components and Programmable Logic Devices: Binary Adders and Subtractors, Comparators, Decoders, Encoders, Multiplexers.			L1, L2, L3
Module -3			
Flip-Flops and its Applications: Introduction to flipflops, SR flip-flops, JK flip flops, The Master-Slave Flip-flops (Pulse-Triggered flip-flops, Characteristic equations, Registers, Binary Ripple Counters, Synchronous Binary Counters, Counters based on Shift Registers, Design of Synchronous mod-n Counter using clocked T, JK, D and SR flip-flops.			L1, L2, L3
Module -4			
Introduction to Verilog: Structure of Verilog module, Operators, Data Types, Styles of Description. Verilog Data flow description: Highlights of Data flow description, Structure of Data flow description.			L1, L2, L3

Module -5	
Verilog Behavioral description: Structure, Variable Assignment Statement, Sequential Statements, Loop Statements, Verilog Behavioral Description of Multiplexers. Verilog Structural description: Highlights of Structural description, Organization of structural description, Structural description of ripple carry adder.	L1, L2, L3
PRACTICAL COMPONENT	
Using suitable simulation software, demonstrate the operation of the following circuits:	
1. To simplify the given Boolean expressions and realize using the Verilog program.	
2. To realize Adder/Subtractor (Full/half) circuits using Verilog data flow description	
3. To realize 4-bit ALU using the Verilog program.	
4. To realize the following Code converters using Verilog Behavioral description a) Gray to binary and vice versa b) Binary to excess3 and vice versa	
5. To realize using Verilog Behavioral description: 8:1 mux, 8:3 encoder, Priority encoder	
6. To realize using Verilog Behavioral description: 1:8 Demux, 3:8 decoder, 2-bit Comparator	
7. To realize using Verilog Behavioral Description:Flip-flops: a) JK type b) SR type c) T type and d) D type	
8.To realize Counters - up/down (BCD and binary) using Verilog Behavioral description	
Text Books: 1. Digital Logic Applications and Design by John M Yarbrough, Thomson Learning, 2001. 2. Digital Principles and Design by Donald D Givone, McGraw Hill, 2002. **Reference Books:** 1. Fundamentals of Logic Design, by Charles H Roth Jr., Cengage Learning 2. Logic Design, by Sudhakar Samuel, Pearson/ Sanguine, 2007 3. Fundamentals of HDL, by Cyril P R, Pearson/Sanguine 2010.	

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction and Principles of Combinational Logic	Difference between combinational and sequential logic, I introduction to canonical forms, Sum of Products (SOP), Product of Sums (POS), Converting Boolean expressions to canonical forms, Introduction to Karnaugh maps, Introduction to the Quine-McCluskey method
2	Week 3-4: Logic Design with MSI Components and PLDs	Overview of Medium Scale Integration (MSI) components, Definition and significance, Comparison with SSI and LSI, Binary addition and subtraction principles, Principles of binary comparison, Principles and applications of decoders, Principles and applications of encoders, multiplexers
3	Week 5-6: Flip-Flops and its Applications	Definition and significance of flip-flops in digital circuits, Pulse-triggered flip-flops: Principles and operation, D flip-flop: Structure, truth table, and operation, Characteristic equations for SR, JK, and D flip-flops, Definition and significance of registers in digital systems and counters
4	Week 7-8: Introduction to Verilog	Structure of Verilog , operators related to the instructions of Verilog, and different description styles of Verilog modelling
5	Week 9-10: Verilog Behavioral and Structural Description	Structure of behavioural modeling style and structural modeling style.
6	Week 11-12: Integration and Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice with programming assignments

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.

3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		**100 marks**

CIE Split up for Integrated Professional Core Course (IPC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Theory (A)	Internal Assessment-Tests (A)	2	**60%**	**15**	**06**
	Assignments/Quiz/Activity (B)	2	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing	Continuous	**60%**	15	06
	Test at the end of the semester	1	**40%**	10	04
	Total Marks		**100%**	**25**	**10**

Final CIE Marks = (A) + (B)

Semester End Examinations(SEE):

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub-questions), may have a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. The question paper may include at least one question from the laboratory component.

5. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Digital Design Fundamentals	Students will grasp the fundamental concepts of digital logic design, including Boolean algebra, logic gates, combinational and sequential circuits, and finite state machines
2	Designing Combinational and Sequential Circuits	Students will learn to design and implement combinational circuits such as adders, multiplexers, and decoders, as well as sequential circuits such as flip-flops, registers, and counters using Verilog
3	Proficiency in Verilog Syntax	Students will become proficient in writing Verilog code to describe digital circuits, including modules, ports, data types, and behavioral and structural modeling techniques.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of digital design and Verilog to design, implement, simulate, and verify complex digital systems, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC304.1	Present the Comprehension of the fundamental building blocks of Digital Systems Design using Verilog HDL.
M23BEC304.2	Apply truth tables and switching equations for digital circuits for K-Maps and Quine-McCluskey methods.
M23BEC304.3	Design combinational and sequential circuits using MSI components and PLDs.
M23BEC304.4	Design combinational and sequential circuits using Verilog modules.
M23BEC304.5	Analyze the outcomes of the simulated Verilog modules of combinational and sequential circuits.
M23BEC304.6	Conduct experiments individually or in a team, present the corresponding outcomes, and process both orally and in writing.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC304.1	-	-	-	-	-	-	-	-	-	-	-	-	--	-
M23BEC304.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC304.3	-	-	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC304.4	-	-	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC304.5	-	-	3	-	-	-	-	-	-	-	-	-	3	-
M23BEC304.6	-	-	-	-	3	-	-	-	2	-	-	-	-	-
M23BEC304	3	-	3	-	3	-	-	-	2	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	10						10
Module 2		10					10
Module 3			10				10

Module 4				10			10
Module 5					5	5	10
Total	10	10	10	10	5	5	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	CO6	**Total**
Module 1	**20**						**20**
Module 2		**20**					**20**
Module 3			**20**				**20**
Module 4				**20**			**20**
Module 5					**10**	**10**	**20**
Total	20	20	20	20	10	10	100

10. Future with this Subject:

The "Digital System Design using Verilog" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

- **Advanced Digital Design Courses:** The knowledge gained in this course, covering principles of combinational and sequential logic, flip-flops, and Verilog HDL, serves as a prerequisite for more advanced courses in digital design. Students can delve deeper into topics such as FPGA-based design, advanced digital system architectures, and high-performance digital systems.
- **Embedded Systems:** Understanding Verilog and its application in digital system design is crucial for students pursuing courses related to embedded systems. The ability to model, simulate, and synthesize digital systems using Verilog is directly applicable in the design and implementation of embedded systems.
- **VLSI Design:** The course provides a solid foundation for students interested in pursuing VLSI (Very Large Scale Integration) design courses. The principles of combinational and sequential logic, along with the skills in using Verilog for structural and behavioral descriptions, are essential for designing complex integrated circuits.
- **Digital Signal Processing (DSP):** Students specializing in DSP benefit from the course by gaining insights into the fundamentals of digital logic and Verilog. This knowledge becomes instrumental when working on DSP algorithms, hardware implementations, and the design of specialized digital signal processors.
- **Computer Architecture and Organization:** The course contributes to the understanding of computer organization and architecture. Concepts such as binary adders, decoders, and multiplexers are foundational to the study of computer architecture, providing insights into how digital systems are organized and interconnected.
- **Advanced Programming Courses:** Students pursuing courses in advanced programming, especially those related to hardware programming or system-level programming, can leverage their knowledge of Verilog for hardware description and simulation. This understanding is valuable when working on software-hardware co-design projects.
- **Project Work and Research:** The hands-on experience gained through programming assignments, problem-solving, and project work in digital system design using Verilog prepares students for more extensive projects in their later years. It equips them with the skills needed for research in the field of digital systems.
- **Industry Applications:** The course provides practical skills that are directly applicable in industries related to digital system design, VLSI, embedded systems, and more. Graduates are well-prepared to contribute to industries developing digital hardware and systems.

In summary, the "Digital System Design using Verilog" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

3rd Semester	Professional Core Course (PC) C++ AND DATA STRUCTURE	M23BEC305

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Programming Concepts	Understanding of concepts of programming. It is essential to have a fundamental programming concept such as variables, data types, control structures (like loops and conditional statements), functions, and arrays.
2.	Key points of programming language	Knowledge of procedural and object-oriented programming. Understanding of high and low-level language, machine code, compiler, interpreter, object and source code, script and interactive mode, algorithms, token, exceptions, semantics, bugs, prompt, problem solving, etc.
3.	Basic Mathematics	Proficiency in matrices, factorial, Fibonacci series, real and imaginary values, Boolean algebra, etc. While not a strict requirement, having a good grasp of basic mathematical concepts like arithmetic, logic, and Boolean algebra can help solve problems and write algorithms in C.
4.	Memory Management	C++ requires manual memory management using concepts like pointers, dynamic memory allocation (malloc, new), and deallocation (free, delete). Understanding how memory works in C and being able to manage it effectively is crucial.
5.	Experience with another Programming Language	Having prior experience with another programming language, especially a C-like language such as C, or Python, can make it easier to learn C++ due to similarities in syntax and programming concepts.

2. Competencies:

S/L	Competency	KSA Description
1.	Language fundamentals	**Knowledge:** Awareness of coding standards, design patterns, and software engineering principles relevant to C++ development. **Skills:** Proficiency in C++ syntax and semantics. **Attitudes:** Commitment to writing error-free code and adhering to coding standards.
2.	Understanding Basic Data Structures	**Knowledge:** Students should be able to identify, define, and explain fundamental data structures such as arrays, linked lists, stacks, queues, trees, graphs, hash tables, and heaps. **Skills:** Designing, analyzing, and evaluating the performance of data structures in C++. **Attitudes:** Appreciation for the role of data structures in an efficient and organized way.
3.	Applications of Data Structures	**Knowledge:** Recognizing real-world problems that can be solved efficiently using specific data structures. **Skills:** Skill in using debugging and profiling tools to diagnose and optimize code. **Attitudes:** Using trees for hierarchical data representation, etc.
4.	Memory Management	**Knowledge:** Understanding memory allocation and deallocation techniques in different programming languages, especially for dynamically allocated data structures like linked lists and trees. **Skills:** Knowledge of C++ new tools features and their usage to write modern, efficient code. **Attitudes:** Openness to learning and using hardware description languages for design.
5.	Practical Problem Solving	**Knowledge:** Solving a variety of problems using data structures and algorithms through programming assignments, and problem-solving sessions. **Skills:**

		We are developing the ability to critically analyze problem scenarios and choose the most appropriate data structures and algorithms to solve them efficiently. **Attitudes:** Willingness to tackle challenging problems and persevere until solutions are found.

3. Syllabus

C++ AND DATA STRUCTURE SEMESTER – III			
Course Code	**M23BEC305**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**2:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- To impart the concepts of Encapsulation, Inheritance and Polymorphism
- To impart problem-solving with oops.
- To impart the problem statement analysis and to build an object-oriented system model
- To impart the concepts of data structures.

Module -1	
Introduction to C++ and Functions: Oops and its principle, Data types, user-defined data types, storage classes, Operators, Scope resolution operator, inline functions, recursion, function overloading, friend functions, classes, and objects	L1, L2, L3
Module -2	
Operator overloading, Inheritance, Polymorphism: Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Derived Classes, Single, multilevel, multiple inheritance	L1, L2, L3
Module -3	
Pointers, Virtual Functions, files, and Exception handling: Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions, Exception handling, throw, catch	L1, L2, L3
Module -4	
Linked list, Linear list, Stacks: Linked List, Linear List - Array representation, Linear List – Linked representation, Arrays and stack and their applications.	L1, L2, L3
Module -5	
Queue, Trees: Array representation, linked representation, queues array representation, linked representation, skip lists and, binary trees, and their applications.	L1, L2, L3

Text Books:

1. E. Balaguruswamy, "Object Oriented Programming with C++", 6th edition, TMH, 2013
2. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", 2nd edition, Tata McGraw Hill Publications, 2005.

Reference Books:

1. Herbert Schildt, "C++ the complete reference", 4thedition, TMH, 2003.
2. Introduction to Data Structure and Algorithms with C++ by Glenn W. Rowe

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to C++ and Functions	Understanding the fundamental concepts of C++ programming, classes and objects, functions, and applications of C++. Knowledge of various data types, user-defined data types, storage classes, Operators, inline functions, recursion, function overloading, friend and virtual functions static data members, and static member functions.
2	Week 3-4: Operator overloading, Inheritance	Operator overloading, and inheritance, single, multiple, multilevel, and hybrid inheritance. Implementing real-time applications of inheritance with base and derived classes, unary and binary operator overloading, etc.

3	Week 5-6: Polymorphism, Pointers, Virtual Functions	Pointers, virtual functions, dynamic memory allocation, pointers to objects and derived classes, this pointer, virtual and pure virtual functions.
4	Week 7-8: Exception handling, introduction of data structures	I/O streams, exception handling, data structures, their classifications, and basic operations. perform operations like insertion, deletion, traversal, and searching, and Exception handling like try(), catch(), and through(), for handling errors.
5	Week 9-10: Linked list, linear list, stacks	Linked lists, linear list, stacks and their properties, and various types. Linear and linked lists are structured with nodes containing data and pointers to the next (and optionally, previous) nodes. Understanding memory allocation for linked list nodes and the concept of garbage collection for reclaiming memory occupied by unused nodes. Different types of linked lists such as singly linked lists, doubly linked lists, and circular linked lists. Implementing linked and linear list operations like insertion, deletion, traversal, and searching efficiently. Ability to manage memory allocation and deallocation for linked list nodes, handle pointer manipulations, and implement different types of linked lists. Understanding the use of linked lists in implementing stacks and other data structures efficiently.
6	Week 11-12: Quees and trees	**Trees:** Hierarchical data structure represented as a tree. **C**oncepts of trees, including nodes, edges, root, parent, child, sibling, leaf, subtree, etc. Understanding the different types of trees, such as binary trees, binary search trees, and selection trees. Knowing the terminology associated with trees, including height, depth, level, and balanced trees. **V**isualizing and interpreting tree structures, identifying and describing tree properties, and understanding tree-related algorithms and operations. Apply learned concepts and competencies to real-world scenarios. **Queues**: **C**oncept of a queue, its properties, and basic operations. How a queue works, including its FIFO (First in, First Out) property, and operations such as enqueue (insertion), dequeue (removal), peek (accessing the front element without removing it), and isEmpty (checking if the queue is empty). Understanding array representation of queues, and implementing circular queues and dynamic arrays for efficient memory management. Ability to apply queue-based algorithms for applications like solving the A-Mazing Problem, implementing deque, and priority queues.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies

7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative, and other Assessments shall be conducted as per the Institution's calendar of events in all the courses of the programme offered to the students, within the framework of the Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE permitted to appear in the SEE of the course.
2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

For a theory course, with an L-T-P distribution of L-0-0, the CIE will carry a maximum of 50% weightage of the total marks of a course. The minimum CIE marks requirement is 40% of the maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations (SEE):

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Syntax and Language Fundamentals	o Students will grasp the fundamental concepts and syntax of C++ including variables, data types, operators, control structures (if-else, loops), functions, and classes. Understand the concepts of scope, lifetime, and storage duration of variables.

		○ Explore different data structures such as arrays, strings, pointers, and dynamic memory allocation.
2	Object-Oriented Programming (OOP)	○ Grasp the principles of object-oriented programming, including encapsulation, inheritance, and polymorphism. ○ Learn how to define and use classes and objects to model real-world entities and relationships. ○ Understand the importance of abstraction and how to design classes with appropriate member functions and data members.
3	Memory Management and Pointers	○ Learn about memory management in C++, including stack vs. heap memory allocation. ○ Understand the concept of pointers and their use in dynamic memory allocation and manipulation. ○ Master pointer arithmetic, pointer manipulation, and common pitfalls like memory leaks and dangling pointers.
4	Standard Template Library (STL)	○ Explore the Standard Template Library (STL) and its components such as containers (lists), algorithms (sorting, searching), and iterators. ○ Learn how to effectively use STL containers and algorithms to simplify and optimize code.
5	Exception Handling	○ Understand the concept of exception handling and how it can be used to handle runtime errors and exceptional conditions. ○ Learn about try-catch blocks, exception types, exception hierarchies, and best practices for error handling.
6	File I/O and Stream Processing	○ Master file input/output operations using streams in C++. ○ Learn how to read from and write to files, handle file streams, and perform text and binary file processing.
7	Concurrency and Multithreading	○ Understand the basics of concurrency and multithreading in C++. ○ Learn how to create and manage threads, synchronize access to shared resources, and avoid race conditions using mutexes and condition variables.
8	Debugging and Testing	○ Develop skills in debugging C++ programs using modern tools ○ Learn about unit testing frameworks and techniques for testing C++ code to ensure correctness and reliability.
9	Best Practices and Coding Standards	○ Familiarize yourself with best practices and coding standards for writing clean, maintainable, and efficient C++ code. ○ Understand concepts like code readability, modularization, naming conventions, and code documentation.
10	Problem-Solving and Algorithmic Thinking	○ Develop problem-solving skills through hands-on coding exercises. ○ Practice breaking down problems into smaller, manageable tasks, and implementing efficient algorithms and data structures to solve them.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC305.1	Understand the basic concepts of object oriented programming and data structures to solve problems.
M23BEC305.2	Acquire knowledge on classes, functions, pointers, operator overloading, inheritance, polymorphism and exception handling concepts to build programming models.
M23BEC305.3	Analyze the performance of Arrays, Stacks, tree and Queue.
M23BEC305.4	Implement applications of C++ and data structures using modern tools.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC305.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC305.2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC305.3	-	3	2	-	-	-	-	-	-	-	-	-	2	2
M23BEC305.4	2	2	2	-	3	-	-	-	-	-	-	-	2	2
M23BEC305	2.66	2.33	2	-	3	-	-	-	-	-	-	-	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	10				1200
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5			5	5	10
Total	10	10	15	15	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5			10	10	20
Total	20	20	30	30	100

10. Future with this Subject:

The future in C++ programming for students is bright, with ample opportunities for learning, growth, and innovation. By mastering C++ and staying engaged with the evolving landscape of programming languages and technologies, students can build a solid foundation for a successful career in software development. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of programming. Here are some notable contributions:

- In-demand Skills: C++ remains a highly sought-after skill in the tech industry, especially for roles in game development, system programming, embedded systems, and performance-critical applications. By mastering C++, students can position themselves for rewarding career opportunities in these fields.
- Modernization: The C++ language continues to evolve with each new standard, introducing modern features and enhancements that make programming more efficient, expressive, and safer. Students can stay ahead of the curve by familiarizing themselves with these newer language features and best practices.
- Cross-platform Development: With the increasing diversity of computing platforms, from desktops to mobile devices to IoT devices, C++ offers a powerful solution for writing code that can run across different environments. Students can explore cross-platform development tools and frameworks to broaden their skill set and reach a wider audience with their applications.
- Open Source Contributions: The C++ community is rich with open-source projects and initiatives, providing students with opportunities to contribute to real-world projects, collaborate with other developers, and gain hands-on experience. Contributing to open-source projects not only helps students hone their programming skills but also allows them to make meaningful contributions to the broader C++ ecosystem.
- Specialized Domains: C++ is widely used in specialized domains such as high-performance computing, scientific computing, and game development, where its performance and efficiency are critical. Students interested in these areas can delve deeper into C++ programming and explore advanced topics such as parallel programming, GPU computing, and game engine development.
- Networking and Community Engagement: Engaging with the C++ community through forums, conferences, and online communities can provide students with valuable networking opportunities, mentorship, and support. By actively participating in the community, students can stay informed about the latest developments in C++ programming, exchange ideas with peers, and build connections that can benefit their future careers.

3rd Semester	Engineering Science Course (ES) SENSORS AND INSTRUMENTATION	M23BEC306A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electrical and Electronic Concepts	Understanding of fundamental electrical principles such as voltage, current, resistance, capacitance, and inductance. This knowledge is foundational for comprehending how sensors operate and how they are integrated into measurement systems.
2	Introduction to Physics	Fundamentals of physics and basic engineering principles are essential for understanding the operation and application of various sensors.
3	Analog and Digital Electronics	Knowledge of analog circuits (e.g., operational amplifiers, filters) and digital electronics (e.g., digital-to-analog converters, microcontrollers). This is essential for processing and interpreting signals from sensors.
4	Measurement Techniques	An understanding of basic measurement techniques, including methods for measuring electrical quantities, error analysis, and calibration. This is crucial for ensuring accurate and reliable sensor measurements.
5	Network theorems	A basic understanding of network theorems like Thevenin's and electrical engineering knowledge is essential for understanding the working principles of bridges and transducers.

2. Competencies

S/L	Competency	KSA Description
1	Understand basic sensor concepts and classification	Knowledge: Definitions, types of sensors, key terms Skills: Ability to identify and classify sensors Attitudes: Curiosity to explore various sensors
2	Understand materials used in sensors	Knowledge: Materials science related to sensors Skills: Choosing appropriate materials for specific applications Attitudes: Open-mindedness to innovative materials
3	Analyze measurement accuracy and errors	Knowledge: Types of static characteristics, error sources Skills: Error analysis and correction techniques Attitudes: Precision and accuracy in measurements
4	Use multirange measurement devices	Knowledge: Principles of multirange meters Skills: Calibration and use of ammeters/voltmeters Attitudes: Diligence in maintaining instrument accuracy
5	Master different DVM techniques	Knowledge: Ramp, Dual slope, Direct compensation, Successive Approximation Skills: Implementing DVMs in circuits Attitudes: Thoroughness in selecting the right DVM technique
6	Use and understand digital multimeters	Knowledge: Functionality of DMM and frequency meters Skills: Accurate measurement of voltage, current, and frequency Attitudes: Responsibility in using measurement tools
7	Understand and utilize bridge circuits	Knowledge: Principles of resistance measurement using bridges Skills: Designing and using Wheatstone and AC bridges Attitudes: Patience in fine-tuning bridge circuits
8	Apply transducers in practical scenarios	Knowledge: Principles and types of transducers Skills: Designing and implementing transducer-based systems Attitudes: Flexibility in adapting to new transducer technologies

3. Syllabus

SENSORS AND INSTRUMENTATION SEMESTER – III			
Course Code	**M23BEC306A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:
- Understand various technologies associated in manufacturing of sensors.
- Acquire knowledge about types of sensors used in modern digital systems.
- Get acquainted about material properties required to make sensors.

• Understand types of instrument errors and circuits for multirange Ammeters and Voltmeters. • Describe principle of operation of digital measuring instruments and Bridges. • Understand the operations of transducers and instrumentation amplifiers.	
Module -1	
Introduction to sensor-based measurement systems: General concepts and terminology, sensor classification, Primary Sensors: Temperature sensors, pressure sensors, flow velocity and flow rate sensors, level sensors, material for sensors, microsensor technology.	L1, L2,L3
Module -2	
Self-generating Sensors-Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors.	L1, L2,L3
Module -3	
Principles of Measurement: Static Characteristics, Error in Measurement, Types of Static Error, Multirange Ammeters, Multirange voltmeter. Digital Voltmeter: Ramp Technique, Dual slope integrating Type DVM, Direct Compensation type and Successive Approximations type DVM.	L1, L2, L3
Module -4	
Digital Multimeter: Digital Frequency Meter and Digital Measurement of Time, Function Generator. Bridges: Measurement of resistance: Wheatstone's Bridge, AC Bridges - Capacitance and Inductance Comparison bridge, Wien's bridge.	L1, L2, L3
Module -5	
Transducers: Introduction, Electrical Transducer, Resistive Transducer, Resistive position Transducer, Resistance Wire Strain Gauges, Resistance Thermometer, Thermistor, LVDT. Instrumentation Amplifier using Transducer Bridge, Temperature indicators using Thermometer, Analog Weight Scale.	L1, L2, L3
Text Books: 1. "Sensors and Signal Conditioning", Ramon Pallas Areny, JohnG. Webster,2nd edition, John Wiley and Sons,2000 2. H.S.Kalsi, "Electronic Instrumentation", McGraw Hill, 3rd Edition,2012,ISBN:9780070702066. **Reference Books** 3. DavidA. Bell, "Electronic Instrumentation & Measurements", Oxford University Press PHI 2ndEdition, 2006, ISBN 81-203-2360-2. 4. D. Helfrickand W.D. Cooper, "Modern Electronic Instrumentation and Measuring Techniques", Pearson, 1st Edition, 2015, ISBN: 9789332556065.	

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to sensor based measurement systems	Understand the General concepts and terminology used in the sensors, sensor classification, Different types of Primary Sensors, material for sensors, micro-sensor technology.
2	Week 3-4: Self-generating Sensors	Understand the working principle of operation of self-generating sensors like Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors .
3	Week 5-6: Principles of Measurement, Digital Voltmeter	Analyze the instrument static Characteristics, Error in Measurement, Types of Static Error, describe the principle of operation of Multirange Ammeters, Multirange voltmeter, Ramp Technique, Dual slope integrating Type DVM, Direct Compensation type and Successive Approximations type DVM.
4	Week 7-8: Digital Voltmeter, Bridges	Describe the principle of operation of Digital Frequency Meter and Digital Measurement of Time, Function Generator, Measurement of resistance using Wheatstone's Bridge, measure passive component values and frequency using AC Bridges - Capacitance and Inductance Comparison bridge, Wien's bridge**.**
5	Week 9-10: Transducers and Instrumentation amplifier	Understand the principle of transducers for measuring physical parameters like Electrical Transducer, Resistive Transducer, Resistive position Transducer, Resistance Wire Strain Gauges, Resistance Thermometer, Thermistor, LVDT. Instrumentation Amplifier using

		Transducer Bridge, Temperature indicators using Thermometer, Analog Weight Scale.
6	Week 11-12: Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice with assignments based projects.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of sensors and instrumentation concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Adopt Flipped class technique by sharing the materials/Sample Videos prior to the class and have discussions on the topic in the succeeding classes.
9	Project based Assignments	Assign project based assignments to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

For a theory course, with an L-T-P distribution of L-0-0, the CIE will carry a maximum of 50% weightage of the total marks of a course.

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

The average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub-questions), may have a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding of sensors	Understand material properties required to make sensors, various technologies associated in manufacturing of sensors, and various types of sensors used in modern digital systems.
2	Understanding of Instrumentation	Understand types of instrument errors, circuits for Multirange Ammeters and Voltmeters, and the operations of transducers, instrumentation amplifiers, digital measuring instruments and Bridges.
3	Project-Based Learning	Through hands-on projects, students will apply their knowledge of sensor techniques for future projects, reinforcing their understanding of theoretical concepts.
4	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
5	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with sensors and instrumentation design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC306B.1	Explain the concept of primary sensors, material properties required and technologies associated in manufacturing of sensors, digital measuring instruments, bridges and transducers.
M23BEC306B.2	Apply the principle of operation of digital measuring instruments, bridges, and transducers to measure various network parameters.
M23BEC306B.3	Apply the instrument characteristics and errors in digital measuring instruments, bridges and transducers.
M23BEC306B.4	Analyze the types of sensors used in modern digital systems to determine their suitability for different applications

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC306B.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC306B.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC306B.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC306B.4	3	3	3	-	-	-	-	-	3	-	2	2	-	-
M23BEC306B	3	3	3	-	-	-	-	-	3	-	2	2	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**3**	**2**	**3**	**2**	**10**
Total	**13**	**12**	**13**	**12**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "Sensors and Instrumentation" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of sensors and instrumentation. Here are some notable contributions:

- Internet of Things (IoT) Integration: Sensors will continue to play a crucial role in the expansion of IoT ecosystems. With sensors embedded in everyday objects and devices, they'll enable seamless data collection, analysis, and automation. This integration will lead to smarter homes, cities, factories, and transportation systems.
- Miniaturization and Wearables: Sensors will become smaller, more efficient, and cheaper, enabling their integration into wearable devices for healthcare monitoring, fitness tracking, and augmented reality applications. These wearable sensors will provide real-time data on vital signs, movement, and environmental factors, revolutionizing personal health and wellness.
- Advanced Medical Diagnostics and Treatment: Sensor technology will advance medical diagnostics and treatment through devices like biosensors, implantable sensors, and wearable health monitors. These innovations will enable early detection of diseases, personalized treatment plans, and remote patient monitoring, improving healthcare outcomes and reducing costs.
- Autonomous Vehicles: Sensors such as LiDAR, radar, and cameras are critical components of autonomous vehicles, enabling them to perceive their surroundings and navigate safely. As autonomous vehicle technology matures, sensor fusion techniques will become more sophisticated, enhancing the vehicles' perception and decision-making capabilities.
- Environmental Monitoring and Sustainability: Sensors will continue to play a vital role in monitoring environmental parameters such as air quality, water quality, and soil conditions. These sensors will help governments, industries, and communities track pollution levels, manage resources more efficiently, and mitigate environmental risks, contributing to sustainability efforts.
- Industrial Automation and Industry 4.0: In manufacturing and industrial settings, sensors will drive the adoption of Industry 4.0 principles, enabling smart factories and automation. Sensors integrated with machines and production systems will enable real-time monitoring, predictive maintenance, and optimization of manufacturing processes, leading to increased productivity and cost savings.
- Quantum Sensors: The emergence of quantum sensors holds promise for ultra-sensitive measurements in various fields, including navigation, imaging, and fundamental research. Quantum sensors leverage the principles of quantum mechanics to achieve unprecedented levels of precision and sensitivity, opening up new possibilities for scientific discovery and technological innovation.
- AI and Data Analytics: With the proliferation of sensors generating vast amounts of data, AI and data analytics will play a crucial role in extracting actionable insights. Machine learning algorithms will analyze sensor data to identify patterns, anomalies, and trends, enabling predictive maintenance, optimization, and decision support across multiple domains.
- Project Work and Research: sensors and instrumentation serve as vital tools for data collection, analysis, and validation across diverse disciplines. Researchers leverage advanced sensor technologies, including but not limited to IoT devices, spectroscopic sensors, and precision measurement instruments, to monitor experimental conditions, environmental variables, and performance metrics in real-time. Integration with emerging technologies such as AI and remote sensing enables researchers to gather comprehensive data, facilitate interdisciplinary collaboration, and accelerate scientific discovery. Customizable and scalable sensor platforms empower researchers to tailor solutions to specific project requirements, while ensuring data security and privacy remains a priority.

3rd Semester	Engineering Science Course (ES) OPERATING SYSTEMS	M23BEC306B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Processor Basics	Familiarity with fundamentals of computer organization and architecture
2	Fundamentals of electronics devices and circuits,	Basic Knowledge of electronic devices, combinational and sequential circuits and their behaviour, Knowledge of binary number system and arithmetic.
3	Basics of Timing and Synchronization	Basic principles of Timing and synchronization circuits
4	Mathematics	Proficiency in basic mathematics so solve memory and scheduling and process problems
5	Programming Fundamentals C/C++	Basic programming skills, understanding of programming concepts (C/C++)
6	Basics of security and protection	Basic Knowledge of protection and security
7	Previous Coursework	Completion of introductory courses in Computer Organization, Digital Electronics, Programming language, and Mathematics.

2. Competencies

S/L	Competency	KSA Description
1.	Operating system structure	**Knowledge:** Understanding the structure of the operating system Knowledge of computer organization. **Skills:** Describing operating system components at different levels **Attitudes:** Openness to learning and using operating systems for different applications
2.	Process synchronization and Deadlocks	**Knowledge:** Understanding process, and critical selection problem. Scheduling, and deadlocks **Skills:** Analyzing and evaluating the performance of synchronization scheduling and deadlocks circuits. **Attitudes:** Appreciation for the role of synchronization, scheduling and deadlocks systems.
3.	Memory devices	**Knowledge:** Understanding of main memory, virtual memory, Mass storage files system. **Skills:** Optimizing the behavior of memory devices, Mass storage and files. **Attitudes:** Valuing the importance of Memory devices mass storage and file system
4.	Protection and security	**Knowledge:** Security principles, authentication, authorization, and access control mechanisms. **Skills:** Apply security measures to protect against unauthorized access, malware, and other security threats. **Attitudes:** Openness to learning and using hardware description languages for design.
5.	Resource management	**Knowledge:** Virtual memory, paging, segmentation, and demand paging. **Skills:**

		Optimizing resource allocation to ensure efficient utilization of CPU, memory, and I/O devices **Attitudes:** Appreciation for the versatility of different techniques

3. Syllabus

OPERATING SYSTEMS SEMESTER – III			
Course Code	**M23BEC306B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- To understand the basic functionalities of Operating System, Process and Threads.
- To understand the implementation of memory management and virtual memory.
- To analyze the usage of different Process and Disk scheduling.
- To make aware of different types of Operating Systems and their services
- To learn different process scheduling algorithms and synchronization techniques
- To learn secondary memory management

Module -1	
Operating System structure: Introduction, Operating System structure; Operating System operations; Process: Basic concept; Process scheduling; Operations on processes; Inter process Communication. Threads: overview, Multicore programming, Multithreading Models, Thread Libraries, Implicit threading, Threading Issues	L1, L2, L3
Module -2	
Process Synchronization: Background, The Critical section problem; Peterson ‘s solution; Synchronization hardware; Semaphores; Classical problems of synchronization; CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling algorithms Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock avoidance; Deadlock detection and recovery from deadlock.	L1, L2, L3
Module -3	
Main Memory: Background, Swapping; Contiguous memory allocation; Segmentation, paging, Structure of page table Virtual Memory: Background; Demand paging; Copy-on-write; Allocation of frames	**L1, L2, L3**
Module -4	
Mass Storage Structures: Overview Mass storage structures; Disk structure, Disk attachment, disk scheduling, Disk management, swap management File System Interface: File concept, Access methods, Directory and disk structure, File system monitoring, File sharing, Protection. File System Implementation: File system structure, File system implementation; Directory implementation; Allocation methods; Free space management	L1, L2, L3
Module -5	
System Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix System Security: Security problem, Program threats, system and Network Threats, cryptography as a security tool, User Authentication	L1, L2, L3

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles, 9th edition, Wiley-India, 2018.
2. Modern Operating Systems, Andrew S Tanenbaum and Herbert Bos, Fourth Edition, Pearson Education,2014
3. William Stallings, Operating Systems internals and design Principles, 7th Edition, 2017.

Reference Books:

1. D.M Dhamdhere: Operating systems - A concept based Approach, 2nd Edition, Tata McGraw-Hill,2002
2. P.C.P. Bhatt: Operating Systems, 2nd Edition, PHI,2006. 3. Harvey M Deital: Operating systems, 3rd Edition, Addison Wesley,1990.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Operating system and process management	Description of operating system , Process scheduling; Inter process Communication Multicore programming, Multithreading Models, Thread
2	Week 3-4: Process Coordination	Process Synchronization; Synchronization hardware; Semaphores; Classical problems of synchronization , CPU Scheduling , Scheduling Algorithms,
3	Week 5-6: Memory Management	Deadlocks Methods for handling deadlocks; Deadlock avoidance; Deadlock detection and recovery from deadlock
4	Week 7-8: Storage Management	Swapping; Contiguous memory allocation; Segmentation, paging, Demand paging; Copy-on-write; Allocation of frames File concept, Access methods, Directory and disk structure File system structure, File system implementation; Directory implementation; Allocation methods; Free space management
5	Week 9-10: Security and Protection:	Principles of protection, Domain of protection, Security problem, Program threats, system and Network Threats, cryptography as a security tool, User Authentication
6	Week 11-12 Integration and Applications	Summarized description of the operating system, Application of operating system

5. Teaching-Learning Process Strategies

Sr.No	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

2) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
3) In such cases where a laboratory is attached to the course, CIE marks shall be awarded separately for both theory and the laboratory. However, the laboratory may or may not have the SEE component in the evaluation.
4) In such cases where a laboratory carries more credits and is not part of the theory, they are listed separately in the Scheme of Teaching and Evaluation. Hence, they are treated as separate “heads of passing” which are assessed and evaluated independently.
5) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
6) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be

on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

For a theory course, with an L-T-P distribution of L-0-0, the CIE will carry a maximum of 50% weightage of the total marks of a course.

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 3 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Fundamentals	Students will grasp the fundamental concepts of operating system process, memory file system and security .
2	Understanding Functionalities	Student will understand the basic functionalities of process , synchronization memory system , file system, security and protection
4	Understanding Algorithms	To analyze the usage of different scheduling algorithms , Dead locks
5	Understanding Implementation	Student will understand the implementation of memory system and security
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with operating system including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC306B.1	Describe the components of operating system process, synchronization scheduling, threads dead locks and memory management policies. Storage management, file system interface protection and security and protection in operating systems.
M23BEC306B.2	Apply the concepts operating system for process, synchronization. Scheduling, threads dead locks and memory management policies. Storage management protection, file system interface and security and protection in operating systems.
M23BEC306B.3	Analyze operating system for process, synchronization. Scheduling, threads, dead locks and memory management policies. Storage management protection, file system interface and security and protection in operating systems
M23BEC306B.4	Present and identify insights of various features of operating systems for process, synchronization. Scheduling, threads, deadlocks and memory management policies. Storage management protection, file system interface and security and protection in operating systems

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC306B.1	3	3	3	2	-	-	-	-	-	-	-	-	3	2
M23BEC306B.2	-	3	2	3	3	-	-	-	-	-	-	-	3	3
M23BEC306B.3	-	3	3	3	-	-	-	-	-	-	-	-	3	2
M23BEC306B.4	3	2	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC306B	3	2.75	2	2.6	3	-	-	-	-	-	-	-	2	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	2	3	2	3	10
Total	12	13	12	13	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "Operating System "course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of computers. Here are some notable contributions:

Operating systems will continue to evolve to meet the changing needs of users. We can expect to see more integration between different devices and platforms, as well as advancements in artificial Intelligence and Machine Learning. The rise of cloud computing and the Internet of Things (IoT) will also play a major role in shaping the future of operating system. Some exciting advancements that are on the horizon for operating systems paving the way for a more efficient, secure and seamless computing environment

1. Artificial Intelligence Integration: One of the most prominent future developments in operating systems is the integration of artificial intelligence (AI) capabilities. AI has already made significant strides in various fields, and its integration into operating systems holds enormous potential. For example, AI can be leveraged to enhance security by detecting and mitigating potential threats in real-time. Additionally, AI-powered virtual assistants can streamline user interactions making tasks such as searching for information, setting reminders, and managing schedules even more intuitive and effortless.
2. Cloud-Based Operating Systems: Cloud computing has revolutionized the way we store and access data and it is now poised to transform operating system as well. Cloud-based operating system allows users to access their files and applications from any device with an internet connection. This eliminates the need for extensive local storage and enables seamless synchronization across multiple devices For instance, Google's Chrome OS is an excellent example of a cloud based operating system, providing users with a light weight and secure computing experience, with all data and applications residing in the cloud.
3. Internet of Things (IoT) Integration: As the Internet of Things (IoT) continues to expand, operating systems are evolving to accommodate the increasing number of connected devices. Future operating system will need to seamlessly integrate with IoT devices, enabling users to control and monitor their smart homes, wearables, and other IoT devices from a central interface. For instance, Apple's HomeKit and Google's Android Things are platforms that allow users to manage their IoT devices through their operating system, providing a unified and convenient user experience
4. Enhanced Security measure: In an increasingly interconnected world, security remains a top concern for operating systems. Future developments will focus on implementing robust security measures to protect user data and privacy. For example, advancements in biometric authentication, such as facial recognition and fingerprint scanning, will enhance the security of devices and Operating systems, making them less susceptible to unauthorized access. Additionally, advancements in encryption algorithms and secure boot processes will further fortify operating systems against potential threats

5. User centric design and Personalization: Operating systems of the future will prioritize user-centric design, allowing users to personalize their computing experience to suit their preferences. For instance, Microsoft's Windows 10 already offers various customization options, enabling users to personalize their desktop backgrounds, themes, and start menus. Future developments may take this personalization further, allowing users to tailor their operating systems to their specific needs, such as organizing workflows, optimizing task management, and customizing user interface.

3rd Semester	Engineering Science Course (ES) 8051 MICROCONTROLLER	M23BEC306C

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Digital Logic	Familiarity with fundamental digital logic gates.
2.	Electronics Knowledge	A basic understanding of electronics principles including digital logic circuits is necessary for working with microcontrollers.
3.	Programming Concepts.	Proficiency in programming languages are essential for writing code to control and interact with microcontrollers. Understanding programming concepts like variables, loops, conditionals, and functions is crucial.
4.	Computer Architecture	Understanding fundamental concepts of computer architecture, such as CPU, memory, I/O devices, and interrupts, will help in grasping how the 8051 operates within a system.
5.	Previous Coursework	Completion of introductory courses in Basic electronics and programming in C

2. Competencies

S/L	Competency	KSA Description
1.	Microcontroller	**Knowledge:** Familiarity with the microcontroller's architecture being studied, including its CPU core, memory organization, input/output (I/O) ports, timers, and interrupt system. **Skills:** Able to use Microcontroller CPU core, memory organization, input/output (I/O) ports, timers, and interrupt system. **Attitudes:** Understand the architecture of the 8051 microcontroller.
2.	Ability to read Data sheet	**Knowledge:** Understanding of datasheets, as they contain detailed information about the microcontroller functionality, pinouts, registers and more. **Skills:** Able to read and understand data sheets for working effectively with a microcontroller. **Attitudes:** Analyze and design embedded systems.
3.	Problem-solving skills	**Knowledge:** Microcontroller projects often involve troubleshooting hardware and software issues, so strong problem-solving skills are essential. **Skills:** The ability to analyze problems, identify root causes, and implement effective solutions is crucial for success. **Attitudes:** Efficiently troubleshoot hardware and software problems.
4.	Hands-on Experience	**Knowledge**: Practical experience in building simple circuits and programming them. **Skills:** Working on projects, and experimenting with different technologies, devices, and techniques emerging regularly**.** **Attitudes:** Commitment to lifelong learning and staying updated with the latest developments in microcontroller technology.

3. Syllabus

8051 MICROCONTROLLER SEMESTER – III			
Course Code	**M23BEC306C**		
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0**	CIE Marks	**50**
Total Number of Lecture Hours	**40**	SEE Marks	**50**
Credits	**3**	Total Marks	**100**

Examination type(SEE)	**Theory**		

Course objectives:

This course will enable students to:

- Analyze the basic architecture of the 8051 microcontroller.
- Program 8051 microcontroller using Assembly Language and C.
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051
- Understand the interrupt structure of 8051 and Interfacing I/O devices using I/O ports of 8051.

Module -1	
Microcontroller: 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.	L1, L2
Module -2	
Instruction Set: 8051 Addressing Modes, Data Transfer Instructions, Arithmetic Instructions, Logical Instructions, Jump & Call Instructions Stack & Subroutine Instructions of 8051 (with examples in assembly Language).	L1, L2, L3
Module -3	
Timers/Counters &Serial port programming: Basics of Timers & Counters, Data types & Time delay in the 8051 using C, Programming 8051 Timers, Mode 1 & Mode 2 Programming, Counter Programming (Assembly Language only). Basics of Serial Communication: 8051 Connection to RS232, Programming the 8051 to transfer data serially & to receive data serially using C.	L1, L2, L3
Module-4	
Interrupt Programming: Basics of Interrupts, 8051 Interrupts, Programming Timer Interrupts, Programming Serial Communication Interrupts, Interrupt Priority in 8051 (Assembly Language only).	L1, L2, L3
Module-5	
I/O Port Interfacing & Programming: I/O Programming in 8051 C, LCD interfacing, DAC 0808 Interfacing, ADC 0804 interfacing, Stepper motor interfacing, DC motor control & Pulse Width Modulation (PWM) using C only.	L1, L2, L3

Suggested Learning Resources:

TEXT BOOKS

1. "The 8051 Microcontroller and Embedded Systems – Using Assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollind. Mckinlay; Phi, 2006 / Pearson, 2006.
2. "The 8051 Microcontroller", Kenneth j. Ayala, 3rd edition, Thomson/Cengage Learning.

REFERENCE BOOKS:

1. "Programming And Customizing The 8051 Microcontroller".,MykePredko Tata McGraw-Hill Edition 1999 (reprint 2003).
2. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014, ISBN: 978-93-329-0125-4.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to 8051 Microcontroller	Explain the fundamental concepts, architecture, and instruction set of the 8051 microcontroller. Use of slides for diagrams and real-life examples to illustrate concepts.
2	Week 3-4: 8051 Instruction set	Introduce the basic components of the instruction set architecture: opcode, operands, addressing modes, etc. Introduce assembly language programming for the 8051 microcontroller, focusing on writing programs using mnemonic instructions. Provide hands-on exercises and examples to reinforce understanding of the instruction set and its usage in programming.
3	Week 5-6 Timers & Counters Serial Data Communication	Explain the concept of timers and counters and their significance in embedded systems. Discuss the difference between timers and counters, their applications, and how they are implemented in the 8051 microcontroller. Examples of timer/counter initialization, configuration, and usage in different applications, such as generating delays, generating PWM signals, etc. Serial Data Communication: Introduce the concept of serial data communication and its importance in connecting microcontrollers with other devices or systems.

		Discuss the advantages of serial communication over parallel communication and the different serial communication standards. Explain the UART architecture and its operation in the 8051 microcontroller. Discuss baud rate generation, data framing, start/stop bits, and error detection mechanisms in UART communication. Introduce the RS-232 standard and its protocol for serial communication.
4	Week 7-8-9: Interrupt Programming:	Explain the concept of interrupts and their importance in real-time embedded systems. Discuss the need for interrupts to handle time-critical events and improve system responsiveness. Explain about the interrupt enable/disable registers in the 8051 microcontroller, such as IE (Interrupt Enable) and IP (Interrupt Priority). Introduce different types of interrupts and its memory locations reserved for storing interrupt vectors and the corresponding interrupt service routines (ISRs). supported by the 8051 microcontroller. Explain the priority levels of interrupts and how they are handled by the microcontroller.
5	Week 10-11-12: I/O Programming in 8051 in C	Explain the concept of I/O ports and their significance in interfacing external devices with the 8051 microcontroller. Discuss the organization of I/O ports as ports 0 to 3 and their corresponding physical pins on the microcontroller Discuss the use of bitwise operators to manipulate individual pins and set/clear their directions (input/output) and states (high/low). Explain how to read data from input ports and write data to output ports using C language functions. Provide examples of reading switch states from input ports and controlling LEDs or other output devices connected to output ports.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of 8051 microcontroller concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate a deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details:

Continuous Internal Evaluation (CIE):

The minimum CIE marks requirement is 40% of the maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

Average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examinations (SEE):

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.

Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Microprocessor and Microcontroller and embedded microcontrollers	Students will learn the difference between Microprocessors and microcontrollers and embedded microcontrollers.
2	architecture of 8051microcontroller	Students will learn and analyze the architecture of the 8051 microcontroller.
3	Programming 8051	Students will learn to write the Program for 8051 microcontroller using Assembly Language and using C.
4	Timers/Counters and Serial port of 8051	Students will learn delay calculation , analyze the operation and use of inbuilt Timers/Counters and Serial port of 8051
5	I/O ports of8051	Students will become proficient in using theinterruptstructureof8051 and Interfacing I/O devices using I/O ports of 8051.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge to design and implement, simulate, and verify complex embedded systems, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

CO's	DESCRIPTION OF THE OUTCOMES
M23BEC306C.1	Describe the architecture, register and memory organization, interrupt structure, addressing modes and instruction set of the 8051 microcontroller.
M23BEC306C.2	Develop programs in assembly language, using appropriate addressing modes with suitable 8051 instruction sets, and in C language.
M23BEC306C.3	Program I/O devices to implement various applications using an 8051 microcontroller.
M23BEC306C.4	Analyze the working of timers/counters and interrupts of the 8051 microcontroller to develop timing-critical applications and choose the appropriate baud rate, data format and flow control required for serial communication for various applications.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC306C.1	3	-	-	-	-	-	-	-	2	-	-	-	-	-
M23BEC306C.2	3	2	2	-	-	-	-	-	-	-	-	-	3	-
M23BEC306C.3	3	2	2	-	-	-	-	-	-	-	-	-	3	-
M23BEC306C.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC306C	3	2.33	2	-	-	-	-	-	-	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**

Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**3**	**2**	**3**	**2**	**10**
Total	**13**	**12**	**13**	**12**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

- The future scope of microcontrollers is vast and dynamic, driven by advancements in technology and the increasing demand for embedded systems across various industries. Here are some key areas where microcontrollers are expected to play a significant role in the future:
- Internet of Things (IoT) Applications: Microcontrollers will continue to be the backbone of IoT devices, enabling connectivity and intelligence in a wide range of applications such as smart homes, wearable's, industrial monitoring systems, and smart cities.
- Edge Computing: With the growing need for real-time data processing and reduced latency, microcontrollers will be utilized for edge computing tasks, enabling devices to process data locally without relying solely on cloud servers.
- Artificial Intelligence (AI) at the Edge: Microcontrollers are increasingly being equipped with AI capabilities, allowing them to perform tasks such as image recognition, natural language processing, and predictive analytics directly on the device, without needing to rely on cloud-based AI services.
- Low-Power Devices: As the demand for battery-powered and energy-efficient devices continues to rise, microcontrollers will evolve to become even more power-efficient while still providing sufficient processing power for various applications.
- Security: With the proliferation of connected devices and the increasing threat of cyber-attacks, microcontrollers will incorporate more robust security features to ensure the integrity and confidentiality of data transmitted and processed by these devices.
- Integration with Sensors and Actuators: Microcontrollers will continue to integrate seamlessly with a wide array of sensors and actuators, enabling the development of sophisticated systems for automation, robotics, and environmental monitoring.
- Medical Devices and Healthcare: Microcontrollers will play a crucial role in the development of wearable health monitoring devices, implantable medical devices, and other healthcare-related applications, contributing to advancements in telemedicine and personalized healthcare.
- Automotive Electronics: With the rise of electric and autonomous vehicles, microcontrollers will be essential components in automotive electronics, controlling various subsystems such as power management, safety features, infotainment systems, and autonomous driving functionalities.
- Education and DIY Projects: Microcontrollers will continue to be popular in educational settings and among hobbyists for learning about electronics, programming, and robotics, fostering innovation and creativity in the maker community.

3rd Semester	Engineering Science Course (ES) MEMS	M23BEC306D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic of Physics	Understanding the principles of mechanics, electromagnetism, and thermo dynamics is crucial
2	Engineering Disciplines	Electrical Engineering: Key areas include circuit design, signal processing, and microelectronics. Mechanical Engineering: Important topics include dynamics, fluid mechanics, and thermodynamics. Materials Science: Understanding material properties, microfabrication techniques, and the behaviour of materials at the microscale.
3	Microfabrication Techniques	Photolithography: The process of transferring patterns onto a substrate. Etching: Techniques like wet etching and dry etching (e.g., reactive ion etching) used to remove material. Deposition: Methods for adding materials, such as chemical vapor deposition (CVD) and physical vapor deposition (PVD). Doping: Introducing impurities into semiconductors to modify their electrical properties.
4	Sensor and Actuator Principles	Sensors: Understanding different types of MEMS sensors, such as accelerometers, gyroscopes, and pressure sensors. Actuators: Knowledge of various actuators used in MEMS, including electrostatic, piezoelectric, and thermal actuators.
5	Control Systems and Electronics	Signal conditioning: Techniques for amplifying and filtering signals from MEMS sensors. Microcontrollers and Embedded Systems: Programming and interfacing microcontrollers with MEMS devices for data acquisition and control.

2. Competencies

S/L	Competency	KSA Description
1	MEMS	**Knowledge:** Understanding of MEMS, Microsystems **Skills:** Ability to apply the concepts of Microfabrication and microsystem **Attitudes:** Appreciation for the importance Microelectronics and microsystems.
2	Micro sensors and Micro actuators	**Knowledge:** Understanding of Micro sensors and micro actuation. **Skills:** Apply the concepts of micro sensors, micro actuators and micro accelerometer **Attitudes:** Appreciation for the role sensors.
3	Thermo mechanics, fracture mechanics, thin film mechanics	**Knowledge:** Understanding of thermos mechanics, fracture mechanics and thin film mechanics **Skills:** Apply the concepts of thermos mechanics, fracture mechanics and thin film mechanics **Attitudes:**Appreciation for the role mechanics
4	Micro fabrication Techniques	**Knowledge:** Basic Principles of Micro fabrication, Lithography, Etching, Deposition Techniques, Material Characterization **Skills:** Proficiency in Fabrication, CAD and Simulation Tools, Process Integration Attitude: Appreciation for the role micro fabrication techniques

3. Syllabus

MEMS SEMESTER – III			
Course Code	**M23BEC306D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**

Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:
1.Understand overview of microsystems their fabrication and application areas
2.Working principles of several MEMS devices
3.Developing mathematical and analytical models of MEMS devices
4.Know method to fabricate MEMS devices
5Various application areas where MEMS devices are used.

Module -1	
Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.	L1, L2
Module -2	
Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Microfluidics. Engineering Science for Microsystems Design and Fabrication: Introduction, Molecular Theory of Matter and Inter-molecular Forces, Plasma Physics, Electrochemistry.	L1, L2
Module -3	
Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	L1, L2
Module -4	
Scaling Laws in Miniaturization: Introduction, scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	L1, L2
Module -5	
Overview of Micro manufacturing: Introduction, Bulk Micro manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing.	L1, L2, L3

Text Book:
1. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley.

Reference Books:
1. Hans H. Gatzen, Volker Saile, Jurg Leuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cengage Learning.

4. Syllabus Timeline

S/L	Syllabus structure	KS Description
1.	Week 1-2 Module 1: Overview of MEMS and Microsystems:	Definition and fundamental concepts MEMS, Distinguishing between MEMS and Microsystems, Evolution of microfabrication, Historical developments in microfabrication techniques, Microsystems and microelectronics with the principles of miniaturization
2	Week 3-4 Module 2: Working Principles of Microsystems	Overview of microsystems and technology, types of micro sensors, principles of micro actuation, MEMS and micro actuators with molecular theory of matter
3	Week 5-6 Module 3: Engineering Mechanics for Microsystems Design:	Engineering mechanics in MEMS, state bending of thin plates, fundamental of mechanical vibration, thermal effects of microstructures, fracture mechanics.
4	Week 7-8 Module 4: Scaling Laws in Miniaturization	significance of scaling laws, Geometric scaling principles, principles of rigid-body dynamics, Principles of electrostatic forces, Fundamentals of fluid mechanics at micro-scale, Basics of heat transfer: conduction, convection, and radiation, Combining different scaling effects in MEMS design

5	Week 9-10 Module 5: Overview of Micro manufacturing	Overview of MEMS technology and applications Principles of bulk micromachining, Fundamentals of surface micromachining, Overview of the LIGA process, Comparative analysis of bulk micromachining, surface micromachining, and LIGA
6	Week 11-12: Integration and practical applications	Project demonstration on MEMS and micro sensors

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate a deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		**100 marks**

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks			**50**	**20**

Final CIE Marks =(A) + (B)

The average internal assessment shall be the average of the 2 test marks conducted.

Semester End Examinations:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the

question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding MEMS	Students will grasp the fundamental concepts of MEMS, Microsystems, Micro sensors,
2	Working principle of microsystem	Students will learn about the working principle of MEMS Design and Fabrication
3	Proficiency in MEMS design	Students will become proficient in MEMS design and microsystem design.
4	Project-Based Learning	Through hands-on projects, students will apply the concepts of MEMS in the future projects
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC306C.1	Present the comprehension of concepts related MEMS, Microsystems, Micro sensors, Micro actuators
M23BEC306C.2	Apply the concepts MEMS to evaluate microsystem design and fabrication.
M23BEC306C.3	Analyse the scaling in miniaturization of scaling body, scaling rigid body dynamics, scaling
M23BEC306C.4	Design Bulk Micro manufacturing, Surface Micromachining, liga process in MEMS

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC306C.1	-	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC306C.2	3		-	-	-	-	-	-	-	-	-	-	-	-
M23BEC306C.3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC306C.4	-		3	-	-	-	-	-	-	-	-	-	-	-
M23BEC306C	3	3	3	-	-	-	-	-	-	-	-	-	2	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**3**	**2**	**3**	**2**	**10**
Total	**13**	**12**	**13**	**12**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**

Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "Micro electro mechanical systems" course in the Third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

1.Healthcare and Biomedical Applications: Development of miniaturized sensors that can be implanted in the body to monitor various health parameters, such as glucose levels, heart rate, and neural activity.

2.Consumer Electronics: Integration of advanced MEMS sensors for better motion detection, orientation, and environmental sensing (e.g., accelerometers, gyroscopes, magnetometers, barometers).

3.Automotive Industry: MEMS sensors play a critical role in enabling autonomous driving by providing accurate environmental sensing, navigation, and collision avoidance capabilities.

3rd Semester	Professional Core Course Laboratory (PCL) ANALOG & DIGITAL SYSTEM DESIGN LABORATORY	M23BECL307

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Analog components	• Understanding of active and passive components. • Familiarity with fundamentals of discrete components and colour codes of resistors, capacitors, inductors and diode etc. Transistor, operational amplifiers.
2.	Electronic Circuits	• Knowledge of basic electronic components and circuits. • Understanding of voltage, current, and their characteristic behaviour in electronic circuits.
3.	Fundamental Digital Electronics Knowledge	• Knowledge of basic digital logic gates (AND, OR, NOT, etc.). • Understanding of Boolean algebra and logic simplification techniques
4.	Fundamental analog Electronics Knowledge	• Knowledge of basic analog circuits such as voltage amplifier, oscillators, op-amps etc.
5.	Previous Coursework	• Completion of introductory courses in Basic electronics and mathematics

2. Competencies

S/L	Competency	KSA Description
1.	Small signal designing – Amplifier circuits using Transistors	**Knowledge:** • Understanding of transistor and its configurations, Knowledge of designing transistor AC and DC models **Skills:** • Ability to apply voltage divider rule, ohms-law, KVL, KCL and Thevenin theorem to design the required analog circuit. • Proficiency in designing small signal voltage amplifier using transistors. **Attitudes:** • Appreciation for designing simple voltage amplifiers using transistor for small signal amplification and analysing the parameters.
2.	Designing LC and Crystal Oscillators	**Knowledge:** • Understanding of positive feedback and their application in oscillator circuits. **Skills:** • Designing LC and crystal oscillators based on specifications. • Analysing and evaluating the performance based on their frequency of application **Attitudes:** • Appreciation for the role of designing basic oscillator circuits for audio and radio frequencies.
3.	Designing of linear operational circuits	**Knowledge:** • Understanding of Op-amp and their applications such as summer, digital to analog converter, active filters etc **Skills:** • Designing op-amp circuits such as summer integrator, differentiator, comparator and DAC, **Attitudes:** • Valuing the importance of using op-amp for arithmetical operations in any system design.
4.	Combinational Logic Circuits	**Knowledge:** • Understanding of combinational logic principles and canonical forms. **Skills:** • Designing combinational logic circuits based on specifications. • Analysing and evaluating the performance of combinational logic circuits.

		Attitudes: • Appreciation for the role of combinational logic in digital systems.
5.	Sequential Logic Circuits	**Knowledge:** • Understanding of flip-flops, registers, and sequential logic principles. **Skills:** • Designing sequential logic circuits with flip-flops. • Optimizing the behaviour of sequential circuits. **Attitudes:** • Valuing the importance of sequential logic in digital system functionality

3. Syllabus

ANALOG & DIGITAL SYSTEM DESIGN LABORATORY SEMESTER – III			
Course Code	**M23BECL307**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Realize and test amplifier and oscillator circuits for the given specifications
- Realize the op-amp circuits for the applications such as DAC, implement mathematical functions and precision rectifiers.
- Design and test the combinational and sequential logic circuits for their functionalities.
- Use the suitable ICs based on the specifications and functions.

LIST OF EXPERIMENTS

Sl. No.	**Experiments (Use discrete components)**
1	Design and set up the BJT common emitter voltage amplifier with and without feedback and determine the gain-bandwidth product, input and output impedances
2	Design and set-up BJT/FET i) Colpitts Oscillator, ii) Crystal Oscillator
3	Design and setup the circuits using op amp: i)Adder, ii)Integrator ,iii)Differentiator and iv)Comparator
4	Design 4-bit R – 2R Op-Amp Digital to Analog Converter (i) for a 4-bit binary input using toggle switches (ii) by generating digital inputs using mod-16
5	Design and implement (a) Full Adder using basic gates and NAND/NOR gates, (b) Full subtractor using NAND/NOR gates, (c) 4-variable function usingIC74151(8:1MUX).
6	Realize (i) Binary to Gray code conversion & vice-versa(IC74139), (ii) BCD to Excess-3 code conversion and vice-versa
7	a) Realize using NAND Gates: i) Master-Slave JK Flip-Flop, ii) D Flip-Flop and iii) T Flip-Flop b) Realize the shift registers using IC7474/7495: (i)SISO (ii) SIPO (iii) PISO (iv) PIPO (v) Ring counter and (vi)Johnson counter.
8	Realize Design Mod–N Synchronous Up Counter & Down Counter using 7476 JK Flip-flop
Self - Study Experiments	
9	Design and Test Clippers and clampers
10	Design and test Astable Multivibrator using 555 Timer.

4. Syllabus Timeline

S/L	**Syllabus Timeline**	**Description**
1	Week 1	LAB Introduction
2	Week 2	Batch A-Design and set up the BJT common emitter voltage amplifier with and without feedback and determine the gain-band Batch A width product, input and output impedances

		Batch B-Design and implement (a) Full Adder using basic gates and NAND gates, (b) Full subtractor using NAND gates, (c) 4-variable function using IC74151(8:1MUX).
3	Week 3	Batch A-Design and set-up BJT/FET i) Colpitts Oscillator, ii) Crystal Oscillator Batch B- Realize (i) Binary to Gray code conversion & vice-versa(IC74139), (ii) BCDtoExcess-3code conversion and vice-versa
4	Week 4	Batch A Design and setup the circuits using opamp: i)Adder, ii) Integrator, iii) Differentiator and iv)Comparator Batch Ba) Realize using NAND Gates: i) Master-Slave JK Flip-Flop,ii) D Flip-Flop and iii)T Flip-Flop b) RealizetheshiftregistersusingIC7474/7495: (i)SISO(ii)SIPO(iii)PISO(iv)PIPO(v)Ringcounterand(vi)Johnsoncounter.
	Week -5	Batch A Design 4-bit R – 2R Op-Amp Digital to Analog Converter (i) for a 4-bit binary input using toggle switches (ii) by generating digital inputs using mod-16 counter. Batch B-Realize Design Mod–N Synchronous Up Counter & Down Counter using 7476 JK Flip-flop
5	Week 6-9:	Note: Batches will be swapped and will carry-out the corresponding Experiments.
6	Week 10	Self-Study Experiment: Design and Test clippers and clampers
7	Week 11	Self-Study Experiment: Astable Multivibrator using 555 Timer
8	Week 12	Revision
9	Week 13	Lab Test

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	• Utilize various teaching methods within the lecture format to reinforce competencies.
2	Problem-Based Learning (PBL)	• Implement PBL to enhance analytical skills and practical application of competencies
3	Collaborative Learning	• Encourage collaborative learning for improved competency application.
4	Real-World Application	• Discuss practical applications to connect theoretical concepts with real-world competencies.

6. Assessment Details (both CIE and SEE)

- CIE marks for a practical course shall be 50 marks.
- The split up of CIE marks for record / journal and test to be split in the ratio 60:40.
- Record write up for individual experiment will be evaluated for 10 Marks.
- Total marks scored for record writing and conduction shall be scaled downed to 30 marks (60% of maximum marks).
- One test for100 marks after the completion of the experiments at the end of the semester.

Test Marks distribution for Experiment based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	60
2	Viva-Voce	40%	40
Total		**100%**	**100**

The Test marks should be scaled down to 20 marks (40% of the **maximum CIE Lab Marks (50)**)

Final CIE in Practical Course:

Marks distribution for Experiment based Practical Course for Final CIE

Sl. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal	60% of the maximum	30
2	Scaled Down marks of test	40% of the maximum	20
Total		**100%**	**50**

SEE for practical Course (Irrespective of Experiment or program based):

1. SEE marks for practical course shall be 50marks.

Marks distribution for Experiment based Practical Course for Final CIE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Amplifier & Oscillators	Design and analyse the BJT/FET amplifier and oscillator circuits.
2	Op-amp and precision rectifier	Design and test Op-amp circuits to realize the mathematical Computations, DAC and precision rectifiers.
3	Combinational logic circuits	Design and test the combinational logic circuits for the given specifications.
4	Sequential Logic circuits	Test the sequential logic circuits for the given functionality.
5	555 Timer	Demonstrate the basic electronic circuit experiments using 555timer.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BECL307.1	Design circuits for amplifiers, oscillators, ADC, Op-amp applications, adders/subtractors, Flip-flops, shift registers, code converters and Counters.
M23BECL307.2	Test circuits for amplifiers, oscillators, ADC, Op-amp applications, adders/subtractors, Flip-flops, shift registers, code converters and Counters.
M23BECL307.3	Analyze circuits for amplifiers, oscillators, ADC, Op-amp applications, adders/subtractors, Flip-flops, shift registers, code converters and Counters.
M23BECL307.4	Present the observation in written / oral form either individually/team.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BECL307.1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BECL307.2	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BECL307.3	2	3	2	2		-	-	-	2	-	-	2	3	3
M23BECL307.4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
M23BECL307	2.66	3	2.66	2	-	-	-	-	2	3	-	2	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**3**	**2**	**3**	**2**	**10**
Total	**13**	**12**	**13**	**12**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "Analog & Digital System Design Laboratory-M23BECL307" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of analog systems. Here are some notable contributions:

- Advanced Analog Design Courses: The knowledge gained in this course, covering principles of linear and integrated and VLSI, serves as a prerequisite for more advanced courses in analog design. Students can delve deeper into topics such as VLSI-based design and ULSI systems.
- Embedded Systems: Understanding LTspice and analog system design is crucial for students pursuing courses related to embedded systems. The ability to model, simulates, and synthesize analog systems using sophisticated tools is directly applicable in the design and implementation of embedded systems.
- VLSI Design: The course provides a solid foundation for students interested in pursuing VLSI (Very Large Scale Integration) design courses. The principles of linear and non-linear devices, along with the skills in using LTspice for simulation and behavioral descriptions, are essential for designing complex integrated circuits.
- Project Work and Research: The hands-on experience gained through simulation design, problem-solving, and project work in analog system design using LTspice prepares students for more extensive projects in their later years. It equips them with the skills needed for research in the field of analog system design.
- Industry Applications: The course provides practical skills that are directly applicable in industries related to analog system design, VLSI, embedded systems, and more. Graduates are well-prepared to contribute to industries developing VLSI hardware and systems.

In summary, the "Analog & Digital System Design Laboratory" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

3rd Semester	Ability Enhancement Course (AE) SOCIAL CONNECT & RESPONSIBILITY	M23BSCK308

Social Connect & Responsibility (AE)			
Course Code	**M23BSCK308**		
Number of Lecture Hours/Week(L:T:P:S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**1**	Total Marks	**100**
For CIE Assessment - ActivitiesReportEvaluationbyCollegeNSSOfficer/HOD/SportsDept/AnyDept.			

Course objectives:

This course will enable students to:

- Provide a formal platform for students to communicate and connect to their surroundings.
- Create a responsible connection with the society.
- Understand the community in general in which they work.
- Identify the needs and problems of the community and involve them in problem–solving.
- Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
- Develop competence required for group living and sharing of responsibilities & gain skills inmobilizing community participation to acquire leadership qualities and democratic attitudes.

Contents:

The course is mainly activity-based and will offer activities for students to connect with fellow human beings, nature,society, and the world.

The course will engage students in interactive sessions, open mic, reading groups, storytelling sessions, and semester-long activities conducted by faculty mentors.

In the following, a set of activities planned for the course have been listed:

Part I:

Plantation and adoption of a tree:

Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONETREE)

They will also make an excerpt, either as a documentary or a photo blog, describing the plant's origin, its usage indaily life, its appearance in folklore and literature - – Objectives, Visit, case study, Report, outcomes.

Part II:

Heritage walk and crafts corner:

Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives,Visit, case study, Report, outcomes.

Part III:

Organic farming and waste management:

The usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campusObjectives, Visit, case study, Report, outcomes.

Part IV:

Water conservation:

Knowing the practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices – Objectives, Visit, case study, Report, outcomes.

Part V :

Food walk:

City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, casestudy, Report, outcomes.

Course outcomes (Course Skill Set):

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

M23BSCK308.1: Communicate and connect to the surroundings.
M23BSCK308.2: Create a responsible connection with the society.
M23BSCK308.3: Involve in the community in general in which they work.
M23BSCK308.4: Notice the needs and problems of the community and involve them in problem–solving.
M23BSCK308.5: Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.

M23BSCK308.6: Develop competence required for group living and sharing responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.

Activities:

The jamming session, open mic, and poetry: Platform to connect to others. Share the stories with others. Share the experience of Social Connect. Exhibit talents like playing instruments, singing, one-act play, art painting, and fine art.

Pedagogy:

The pedagogy will include interactive lectures, inspiring guest talks, field visits, social immersion, and a course project. Applying and synthesizing information from these sources to define the social problem to address and take up the solution as the course project with your group. Social immersion with NGOs/social sections will be a crucial course part.

Course topics:

The course will introduce social context and various players in the social space and present approaches to discovering and understanding social needs. Social immersion and inspiring conversations will culminate in developing an idea for problem-based intervention based on an in-depth understanding of a critical social problem.

Duration:

40 - 50 hrs engagement per semester is required for the 3rd semester of the B.E./B.Tech. Program. The students will be divided into groups. A faculty mentor will handle each group. Faculty mentors will design the activities (particularly Jamming sessions, open mic, and poetry). Faculty mentors have to design the evaluation system as per the guidelines of the scheme & syllabus.

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE):

After completion of the course, the student shall prepare, with a daily diary as a reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The mentor should sign the Report. The Report shall be evaluated based on the following criteria and/or other relevant criteria for the completed activity. Marks allotted for the diary are out of 50. Planning and scheduling the social connect

Information/Data collected during the social connect Analysis of the information/data and report writing

Considering all the above points, allotting the marks as mentioned below

Excellent: 80 to 100

Good: 60 to 79

Satisfactory: 40 to 59 Unsatisfactory and fail: <39

Special Note:

NO SEE – Semester End Exam – Completely Practical and activities based valuation

Pedagogy – Guidelines:

It may differ depending on local resources available for the study as well as environment and climaticdifferences, location, and time of execution.

Sl. No	Topic	Group size	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Plantation and adoption of a tree:	May be individual or team	Farmers land/ parks / Villages/roadside/ community area / College campus etc	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by Faculty
2.	Heritage walk and crafts corner:	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by Faculty
3.	Organic farming and waste management:	May be individual or team	Farmers land/ parks / Villages visits/ roadside/ community area / College campus etc	Group selection / proper consultation / Continuous monitoring /	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by Faculty

				Information board		
4.	Water conservation & Conservation Techniques:	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/	Site selection / Proper consultation/ Continuous	Report should be submitted by an	Evaluation as per the rubrics of
			Government Schemes officers / campus etc…	monitoring/ Information board	individual to the concerned evaluation authority	the scheme and syllabus by Faculty

Plan of Action (Execution of Activities)

Sl.NO	Practice Session Description
1.	Lecture session in the field to start activities
2.	Students' Presentation on Ideas
3.	Commencement of activity and its progress
4.	Execution of Activity
5.	Execution of Activity
6.	Execution of Activity
7.	Execution of Activity
8.	Case study based Assessment, Individual performance
9.	Sector/ Team wise study and its consolidation
10.	Video-based seminar for 10 minutes by each student At the end of the semester with a Report.

- Each student should do activities according to the scheme and syllabus.
- At the end of the semester student performance must be evaluated by the faculty for the assigned activityprogress and completion.
- At last consolidated Report of all activities from 1st to 5th, compiled Report should be submitted per the instructions and scheme.

Assessment Details:

Weightage	CIE 100%
Field Visit, Plan, Discussion	10 Marks
Commencement of activities and its progress	20 Marks
Case Study-based Assessment Individual Performance with Report	20 Marks
Sector-wise study & its consolidation 5*5 = 25	25 Marks
Video based seminar for 10 minutes by each student. At the end of semester with Report. Activities 1 to 5, 5*5 = 25	25 Marks
Total marks for the course in each semester	100 Marks

- Implementation strategies of the project (NSSwork).
- The last Report should be signed by the NSS Officer, the HOD, and the principal.
- At last Report should be evaluated by the NSSofficer of the institute.
- Finally, the consolidated marks sheet should be sent to the university and made available at theLIC visit.

For each activity, 20 marks CIE will be evaluated for IA marks at the end of the semester. Report andassessment copy should be made available in the department.

Students should present the progress of the activities as per the schedule in the prescribed practical session in the field.
There should be positive progress in the vertical order for society's general benefit through activities.

3rd Semester	Ability Enhancement Course (AE-III) TECHNICAL WRITING USING LATEX	M23BEC309A

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	LaTeX Distribution	Install a LaTeX distribution such as TeX Live, MiKTeX, or MacTeX. These distributions contain all the necessary programs and packages to compile LaTeX documents.
2.	TeX Editor	Choose a text editor or an integrated development environment (IDE) that supports LaTeX and is suitable for technical writing. Some popular choices include TeXworks, TeXShop, Overleaf, and LaTeXila. Editors with features like syntax highlighting, autocomplete, and project management can be particularly useful.
3.	Document Class	Select a suitable document class for technical documents. While the article class is commonly used, you might also consider report or book depending on the length and complexity of your document.
4.	Compiler	Understand the LaTeX compiler options. For most cases, pdflatex is suitable, but for documents requiring advanced font features or Unicode support, xelatex or lualatex might be preferred.
5.	Basic LaTeX Commands	Learn essential LaTeX commands for technical writing, including formatting text, creating sections, lists, tables, mathematical expressions, and referencing figures, tables, and equations.

2. Competencies

S/L	Competency	KSA Description
1.	Proficiency in LaTeX	**Knowledge**: Master the LaTeX syntax and commands for document formatting, including text formatting, sectioning, creating lists and tables, mathematical typesetting, cross-referencing, and bibliography management. **Skills**: Applying basic mathematics and programming skills to find effective solutions. **Attitudes:** Methodical approach to problem-solving, Programming and documentation skills, Critical Thinking.
2.	Document Structuring	**Knowledge:** Understand how to structure technical documents effectively, including organizing content into logical sections, subsections, and paragraphs for clarity and readability. **Skills:** Designing, analyzing, and evaluating the performance of documentation structuring. **Attitudes:** Appreciation for the role of documentation in an efficient and organized way.
3.	Graphics Integration	**Knowledge:** Learn how to include figures, diagrams, and charts in LaTeX documents using the graphics package. Understand image formats, resolution considerations, and techniques for effective graphics integration. **Skills:** Learn how to include figures, diagrams, and charts in LaTeX documents using the graphicx package. **Attitudes:** Commitment to writing error-free code and integrating the figures and graphics with text documents.
4.	Mathematical Typesetting	**Knowledge:** Understand how to typeset equations, matrices, symbols, and mathematical expressions with clarity and precision. **Skills:** Develop proficiency in mathematical typesetting using LaTeX's math mode and the amsmath package.

		Attitudes: Mathematical approach to problem-solving, programming and integrating mathematical formulas and equation numbers, and critical Thinking.
5.	Cross-Platform Compatibility	**Knowledge:** Ensure cross-platform compatibility of LaTeX documents by using portable LaTeX distributions and avoiding platform-specific dependencies or packages. **Skills:** Skill in using Matlab, python, and figure formats like png, jpeg, jpg, etc., and integrating into the text files **Attitudes:** Basic mathematics, python, mathematics extracted output files, CSV files, and word and excel files must be integrated into the documentation.

3. Syllabus

TECHNICAL WRITING USING LATEX
SEMESTER – III

Course Code	**M23BEC309A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Credits	**1**	Exam Hours	**03**

Course objectives: This course will enable students:

- To introduce the basic syntax and semantics of the LaTeX scripting language
- To understand the presentation of tables and figures in the document.
- To illustrate the LaTeX syntax to represent the theorems and mathematical equations.
- To use the libraries (Tikz, algorithm) to design the diagram and algorithms in the document..

Sl. No.	**To realize the following programs using LATEX software:**
1	Develop a LaTeX script to create a simple document that consists of 2 sections [Section1, Section2], and a paragraph with dummy text in each section. And also include header [title of document] and footer [institute name, page number] in the document.
2	Develop a LaTeX script to create a document that displays the sample Abstract/Summary.
3	Develop a LaTeX script to create a simple title page for the VTU project Report [Use suitable Logos and text formatting]
4	Develop a LaTeX script to create the Certificate Page of the Report [Use suitable commands to leave the blank spaces for user entry]
5	Develop a LaTeX script to create a document that contains the following table with proper labels.

Sl. No.	USN	Student Name	Marks		
			Subject1	Subject 2	Subject 3
1.	4MH23EC001	Name 1	89	63	45
2.	4MH23EC002	Name 2	93	59	77
3.	4MH23EC003	Name 3	58	97	85

6	Develop a LaTeX script to include the side-by-side graphics/pictures/figures in the document by using the subgraph concept.
7	Develop a LaTeX script to create a document consisting of any two mathematical equations of summation, integration and differentiation, limits etc.
8	Develop a LaTeX script to demonstrate the presentation of Numbered theorems, definitions, corollaries, and lemmas in the document
9	Develop a LaTeX script to create a document consisting of two paragraphs with a minimum of 10 citations and display the reference in the section.
10	Develop a LaTeX script to design a simple tree diagram or hierarchical structure in the document with appropriate labels using the Tikz library.

Suggested Learning Resources:

1. A Short Introduction to LaTeX BY FIRUZA KARMALI (AIBARA), A book for beginners, 2019
2. Formatting Information: A Beginner's Introduction to Typesetting with LaTeX, BY PETER FLYNN, Comprehensive TeX Archive Network (2005).
3. LaTeX TUTORIAL: [https://latex-tutorial.com/tutorials/]

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-2:	Develop a LaTeX script to create a simple document that consists of 2 sections [Section1, Section2], and a paragraph with dummy text in each section. And also include header [title of document] and footer [institute name, page number] in the document. Develop a LaTeX script to create a document that displays the sample Abstract/Summary.
2.	Week 3-4:	Develop a LaTeX script to create a simple title page of the VTU project Report [Use suitable Logos and text formatting] Develop a LaTeX script to create the Certificate Page of the Report [Use suitable commands to leave the blank spaces for user entry]
3.	Week 5-6:	Develop a LaTeX script to create a document that contains the following table with proper labels. Develop a LaTeX script to include the side-by-side graphics/pictures/figures in the document by using the subgraph concept.
4.	Week 7-8:	Develop a LaTeX script to create a document consisting of any two mathematical equations of summation, integration and differentiation, limits, etc. Develop a LaTeX script to demonstrate the presentation of Numbered theorems, definitions, corollaries, and lemmas in the document.
5.	Week 9-10:	Develop a LaTeX script to create a document consisting of two paragraphs with a minimum of 10 citations and display the reference in the section.
6.	Week 11-12:	Develop a LaTeX script to design a simple tree diagram or hierarchical structure in the document with appropriate labels using the Tikz library.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of the concepts of Microsoft word and Excel.
3.	Collaborative Learning	Encourage collaborative learning for improved competency application.
4.	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6.	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
7.	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies.
8.	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **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 (CIE):

- CIE marks for the practical course are **50 Marks.**
- The split-up of CIE marks for record and test are in the ratio **60:40.**

Class Work:-A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to **30marks** (60% of the maximum Marks)

Laboratory Test: -B

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to **20marks** (40% of the maximum Marks)

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record/journal-A	60% of the maximum	30
2	Scaled Down marks of test-B	40% of the maximum	20
Total		**100%**	**50**

Final CIE Marks =(A) + (B)

Semester End Evaluation (SEE):

1. SEE marks for the practical course shall be 50 marks

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for **100 marks** and scored marks shall be scaled down to **50 marks**.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.

Duration of SEE shall be **2 hours**.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Develop simple document	Students will realize the Latex software and demonstrate how to create a simple document.
2	To present the tables and figures in the document	Students will develop a LaTeX script to present the tables and figures in the document
3	To present theorems and mathematical equations in the document	Students will Illustrate LaTeX script to present theorems and mathematical equations in the document and it will help to create the technical document.
4	To generate the complete report	Students will Develop programs to generate a complete report with citations and a bibliography
5	Use of Tikz and algorithm libraries	Students will Illustrate the use of Tikz and algorithm libraries to design graphics and algorithms in the document. Students will understand to add the figures and graphics.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

Cos	Description
M23BEC309A.1	Create text documents using latex packages and commands.
M23BEC309A.2	Create and edit mathematical formulae and Tables.
M23BEC309A.3	Insert figures and images using latex packages.
M23BEC309A.4	Write article/letters/resumes using Latex.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC309A.1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BEC309A.2	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BEC309A.3	2	3	2	2	-	-	-	-	2	-	-	2	3	3
M23BEC309A.4	-	-	-	-	2	-	-	-	2	3	-	-	-	-
M23BEC309A	2.66	3	2.66	2	2	-	-	-	2	3	-	2	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	Total
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**

Module 4				**10**	**10**
Module 5	**2**	**3**	**2**	**3**	**10**
Total	**12**	**13**	**12**	**13**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The future of LaTeX, the document preparation system, is likely to see continued development and refinement. Here are some potential directions:

1. Enhanced Collaboration Features: Future versions of LaTeX might integrate better collaboration tools, making it easier for multiple authors to work on a document simultaneously, similar to what we see in platforms like Google Docs.
2. Improved User Interfaces: There could be advancements in LaTeX editors, providing more intuitive interfaces with features such as real-time previews, intelligent auto-completion, and drag-and-drop functionality.
3. Integration with AI: LaTeX could potentially integrate with AI tools to assist users in various tasks, such as suggesting optimal document structures, generating LaTeX code from plain text, or providing intelligent formatting suggestions.
4. Support for Rich Media: With the increasing importance of multimedia content, LaTeX might evolve to better support the inclusion of rich media elements such as videos, interactive graphics, and 3D models.
5. Cross-Platform Compatibility: Future versions of LaTeX may focus on improving compatibility across different platforms and devices, ensuring a consistent experience for users regardless of the software or operating system they're using.
6. Streamlined Workflows: Efforts could be made to streamline the LaTeX workflow, reducing the complexity of certain tasks, optimizing compilation times, and providing better error handling and debugging capabilities.
7. Accessibility Features: There might be an increased emphasis on making LaTeX documents more accessible to users with disabilities, with improvements in screen reader compatibility, alternative text support, and other accessibility features.

3rd Semester	Ability Enhancement Course (AE-III) Lab VIEW	M23BEC309B

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Mathematics	Proficiency in basic arithmetic operation like Addition, Subtraction, Multiplication, Division, Convolution etc..
2.	Boolean Algebra	Proficiency in Boolean operation like AND, OR, XOR, NOT and NAND.
3.	Flow control Statements	Proficiency in all the Flow control Statements like while statement, for statement, if statement, else statement.
4.	Arrays and Matrices	Proficiency in creating arrays, accessing of array element, modifying array elements, iterating over array, types of matrix and its inverse.
5.	Virtual Instruments	Proficiency in various types of control systems, Sensors, mathematical formulae, simulation tool, Error debugging.
6.	Simulations	Familiarity with programming languages and simulation tools.

2. Competencies

S/L	Competency	KSA Description
1.	Mathematics	**Knowledge**: Proficiency in basic arithmetic operation like Addition, Subtraction, Multiplication Division, Convolution etc. **Skills**: Applying basic mathematics and programming skills to find effective solutions. **Attitudes:** Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking.
2.	Boolean Algebra	**Knowledge:** Proficiency in Digital logic operation like AND, OR, NOT, EXOR. **Skills:** Applying concepts of Digital logic and programming skills to find effective solutions. **Attitudes:** Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking.
3.	Flow control Statements	**Knowledge:** Proficiency in various Syntax, Decision making, loop construction, error debugging, flow control analysis, Library functions. **Skills:** Utilizing the syntax and library functions required to write a program. Ability to analyze the flow control statement. **Attitudes:** Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking.
4.	Arrays and Matrices	**Knowledge:** Proficiency in Declaration and Initialization of single, multi-dimensional array, Library functions, Array operations, Matrix. Its types and inverse of a matrix. **Skills:** Applying the concepts of array, matrix and required library functions to write a program. **Attitudes:** Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking.
5.	Virtual Instruments	**Knowledge:** Proficiency in various types of control systems, Sensors, mathematical formulae, simulation tool, Error debugging. **Skills:** Utilize the types of control systems and apply mathematical formulae and simulation tool to build virtual instrument.

		Attitudes: Methodical approach to problem-solving, Programming and Simulation Skills, Critical Thinking, Designing Skills.

3. Syllabus

LabVIEW **SEMESTER – III**			
Course Code	**M23BEC309B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:0:2)**	SEE Marks	**50**
Credits	**1**	Exam Hours	**03**

Course objectives: This course will enable students:

- Aware of various front panel controls and indicators.
- Connect and manipulate nodes and wires in the block diagram.
- Locate various toolbars and pull-down menus for the purpose of implementing specific functions.
- Locate and utilize the context help window.
- Familiar with LabVIEW and different applications using it.
- Run a Virtual Instrument (VI).

Sl. No.	**To realize the following programs using LabView software:**
1.	Basic arithmetic operations and Boolean operations: addition, subtraction, multiplication, division, AND, OR, XOR, NOT and NAND.
2.	a. Sum of 'n' numbers using 'for' loop b. Factorial of a given number using 'for' loop
3.	a. Determine the square of a given number. b. Factorial of a given number using a 'while 'loop.
4.	Sorting even numbers using a 'while' loop in an array.
5.	Finding the array maximum and array minimum.
6.	Find the convolution of two given signals.
7.	Find the inverse of a matrix.
8.	Verify half adder and full adder.
9.	Build a Virtual Instrument that simulates a heating and cooling system. The system must be able to be controlled manually or automatically.
10.	Build a Virtual Instrument that simulates a Basic Calculator (using formula node).
11.	Build a Virtual Instrument that simulates a Water Level Detector.
12.	Demonstrate how to create a basic VI which calculates the area and perimeter of a circle.

Suggested Learning Resources:

1. Virtual Instrumentation using LABVIEW, Jovitha Jerome, PHI, 2011
2. Virtual Instrumentation using LABVIEW, Sanjay Gupta, Joseph John, TMH, McGraw Hill, Second Edition, 2011.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-2:	Introduction, Basic arithmetic operations and Boolean operations: addition, subtraction, multiplication, division, AND, OR, XOR, NOT and NAND.
2.	Week 3-4:	Applying the concepts of basic mathematics, flow control statements and programming and simulation skills to compute sum of n numbers and factorial of number using for loop.
3.	Week 5-6:	Applying the concepts of basic mathematics, flow control statements, programming and simulation skills to sort even numbers using while loop in array and to find array maximum and minimum and also to compute convolution of two signals.
4.	Week 7-8:	Applying the concepts of basic mathematics, flow control statements, programming and simulation skills to compute inverse of a matrix and also to verify half adder and full adder.
5.	Week 9-10:	Applying the knowledge of control system and LabVIEW proficiency to build a Virtual Instrument that simulates heating and cooling system and a basic calculator.
6.	Week 11-12:	Applying the knowledge of control system and LabVIEW proficiency to build a Virtual Instrument that simulates Water Level Detector and to demonstrate VI that calculates the area and perimeter of a circle.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of the concepts of Control System.
3.	Collaborative Learning	Encourage collaborative learning for improved competency application.
4.	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6.	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

Laboratory-based Ability Enhancement Courses and other courses with 1 Credit:
This section of regulations applies to all laboratory-based, activity-based, and experiential learning courses viz., Social Innovation, Engineering Exploration, Career Electives (Add-on Courses), etc.

Class Work:- A

CIE Split up for Laboratory based Ability Enhancement Course

Sl. No.	Description	% of Marks	In Marks
1.	Write-up, Conduction, result and Procedure	60%	30
2.	Viva-Voce	40%	20
	Total	**100%**	**50**

The Test marks should be scaled down to 30marks (60% of the maximum Marks)

Laboratory Test: -B

CIE Split up for Test in Laboratory based Ability Enhancement Course

Sl. No.	Description	% of Marks	In Marks
1.	Write-up, Conduction, result and Procedure	60%	30
2.	Viva-Voce	40%	20
	Total	**100%**	**50**

The Test marks should be scaled down to 20marks (40% of the maximum Marks)

Final CIE for Laboratory based Ability Enhancement Course

Sl. No.	Description	% of Marks	In Marks
1.	Scaled Down marks of record/journal-A	60% of the maximum	30
2.	Scaled Down marks of test-B	40% of the maximum	20
	Total	**100%**	**50**

Final CIE Marks = (A) + (B)

SEE for practical Course (Irrespective of Experiment or program based):

1. SEE marks for practical course shall be 50 marks

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
	Total	**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. The duration of SEE shall be 3 hours.

7. **Learning Objectives**

S/L	Learning Objectives	Description
1	Proficiency in Basic mathematical operation	Students will realize the Basic mathematical operations such as Addition, Subtraction, Multiplication, Division, Arrays, Matrices, and convolution of two signals using LABVIEW and also demonstrate how to create a basic VI which calculates the area and perimeter of a circle.
2	Proficiency in Boolean operation	Students will realize the Boolean operations such as AND, OR, NOT, XOR, and NAND using LABVIEW.

3	Proficiency in Flow Control Statements	Students will realize the Basic mathematical operations used in Flow Control Statements such as while statements, for statements, if statements, and else statements.
4	Proficiency in Fundamentals of Control Systems	Students will build a Virtual Instrument that simulates a heating and cooling system, a Basic Calculator, Water Level Detector using the fundamentals of Control Systems and LABVIEW.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with the design of a system, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

Cos	Description
M23BEC309B.1	Use the programming structures and data types to implement various operations in LabVIEW.
M23BEC309B.2	Create user interfaces with various controls and indicators.
M23BEC309B.3	Analyze and debug the outcomes of VI programs.
M23BEC309B.4	Present the observation in written /oral form either individually/a team.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC309B.1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BEC309B.2	3	3	3	2	-	-	-	-	-	-	-	2	3	3
M23BEC309B.3	2	3	2	2	-	-	-	-	2	-	-	2	3	3
M23BEC309B.4	-	-	-	-	2	-	-	-	2	3	-	-	-	-
M23BEC309B	2.66	3	2.66	2	2	-	-	-	2	3	-	2	3	3

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**2**	**3**	**2**	**3**	**10**
Total	**12**	**13**	**12**	**13**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	Total
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "LabVIEW" course in the third semester of the B.E program lays a strong foundation for several future simulation related courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of Automation and Robotics. Here are some notable contributions:

1. Integration with AI and Machine Learning: LabVIEW is likely to incorporate more features for seamless integration with AI and machine learning algorithms. This would empower engineers and scientists to develop advanced systems for data analysis, prediction, and control.
2. IoT and IIoT Connectivity: With the proliferation of IoT (Internet of Things) and IIoT (Industrial Internet of Things), LabVIEW is expected to offer enhanced connectivity options for interfacing with a wide range of sensors, actuators, and devices, enabling the development of smart systems and Industry 4.0 applications.

3. Cloud Integration: As cloud computing continues to gain prominence, LabVIEW may offer more tools and libraries for integrating with cloud platforms. This would facilitate remote monitoring, data storage, and analysis, making it easier to deploy and manage distributed systems.
4. Enhanced Visualization and User Interface: Future versions of LabVIEW might focus on improving data visualization capabilities and user interface design. This would enable engineers to create more intuitive and user-friendly applications, enhancing productivity and user experience.

3rd Semester	Ability Enhancement Course (AE-III) MICROCONTROLLER LABORATORY	M23BEC309C

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Digital Logic	Familiarity with fundamental digital logic concepts such as gates, flip-flops, and combinational and sequential circuits.
2.	Electronics Knowledge**:**	A basic understanding of electronics principles including digital logic is beneficial
3.	Programming Concepts.	Proficiency in programming languages such as C, C++, or assembly language is essential for writing code to control and interact with microcontrollers. Understanding programming concepts like variables, loops, conditionals, and functions is crucial.
4.	Understanding of Microcontroller Architecture	Basic knowledge of microcontroller architecture, including the CPU core, memory organization, input/output (I/O) ports, timers, interrupts, and serial communication interfaces.
5.	Knowledge of Communication Protocols	Basic understanding of serial communication protocols such as UART, SPI, and I2C, which are commonly used for interfacing microcontrollers with peripheral devices.
6.	Circuit Prototyping Skills.	Ability to prototype simple circuits on a breadboard and connect peripheral devices such as LEDs, switches, sensors, and motors to the microcontroller.
7.	Basic Debugging Techniques**:**	Familiarity with Debugging microcontroller code with breakpoints and step-through in your IDE or debugger can be a useful technique
8.	Datasheet Reading**:**	Proficiency in reading and understanding microcontroller datasheets to interpret specifications, pin configurations, electrical characteristics, and register descriptions.
9.	Previous Coursework	Completion of introductory courses in Basic electronics, digital electronics,8051microcontroller and programming in C.

2. Competencies

S/L	Competency	KSA Description
1.	Microcontroller	**Knowledge:** Familiarity with the architecture of the microcontroller being studied, including its CPU core, memory organization, input/output (I/O) ports, timers, and interrupt system. **Skills:** Able to use Microcontroller CPU core, memory organization, input/output (I/O) ports, timers, and interrupt system. **Attitudes:** Understand the architecture of the 8051 microcontroller
2.	Ability to read Data sheet	**Knowledge:** Understanding of datasheets, as they contain detailed information about the microcontroller's functionality, pin outs, registers and more. **Skills:** Able to read and understand data sheet for working effectively with a microcontroller. **Attitudes:** Analyze and design embedded system.
3.	Problem solving skills	**Knowledge:** Microcontroller projects often involve troubleshooting hardware and software issues, so strong problem-solving skills are essential. **Skills:** The ability to analyze problems, identify root causes, and implement effective solutions is crucial for success. **Attitudes:** Efficiently troubleshoot hardware and software problems.
	Hands on Experience	**Knowledge**: Practical experience in building simple circuits and programming them. **Skills:** Working on projects, and experimenting with different technologies, devices, and techniques emerging regularly**.** **Attitudes:** commitment to lifelong learning and staying updated with the latest developments in microcontroller technology.

3. Syllabus

MICROCONTROLLER LABORATORY SEMESTER – III			
Course Code	**M23BEC 309C**	CIE Marks	**50**
Teaching Hours/Week(L:T:P)	**0:0:2**	SEE Marks	**50**

Credits	**01**	Total Marks	**100**
		Exam Hours	**3**
Examination type (SEE)	**Practical**		

Course objectives: This course will enable students to:

- Understand the basic programming of Microcontrollers.
- Develop the 8051 Microcontroller-based programs for various applications using Assembly Language & C Programming.
- Program 8051 Microcontroller to control an external hardware using suitable I/O ports.

Note	Execute the following experiments by using Keil Micro vision Simulator (any 8051 Microcontroller can be chosen as the target) and Hardware Interfacing Programs using 8051 Trainer Kit.
Sl. No	**I. Assembly Language Programming**
Data Transfer Programs:	
1	Write an ALP to move a block of n bytes of data from source (20h) to destination (40h) using Internal- RAM.
2	Write an ALP to move a block of n bytes of data from source (2000h) to destination (2050h) using External RAM.
3	Write an ALP to exchange the source block starting with address 20h, (Internal RAM) containing N(05) bytes of data with destination block starting with address 40h (Internal RAM).
4	Write an ALP to exchange the source block starting with address 10h (Internal memory), containing n (06) bytes of data with destination block starting at location 00h (External memory).
Arithmetic & Logical Operation Programs:	
5	Write an ALP to add the byte in the RAM at 34h and 35h, store the result in the register R5 (LSB) and R6 (MSB), using Indirect Addressing Mode.
6	Write an ALP to subtract the bytes in Internal RAM 34h & 35h store the result in register R5 (LSB) & R6 (MSB).
7	Write an ALP to multiply two 8-bit numbers stored at 30h and 31 hand store16-bit result in 32h and 33h of Internal RAM.
8	Write an ALP to perform division operation on 8-bit number by 8-bit number.
9	Write an ALP to separate positive and negative in a given array.
10	Write an ALP to separate even or odd elements in a given array.
11	Write an ALP to arrange the numbers in Ascending & Descending order.
12	Write an ALP to find Largest & Smallest number from a given array starting from 20h & store it in Internal Memory location 40h.
Counter Operation Programs:	
13	Write an ALP for Decimal UP-Counter.
14	Write an ALP for Decimal DOWN-Counter.
15	Write an ALP for Hexadecimal UP-Counter.
16	Write an ALP for Hexadecimal DOWN-Counter.
	II.C Programming
1	Write an8051 C program to find the sum of first 10 Integer Numbers.
2	Write an 8051C program to find Factorial of a given number.
3	Write an 8051 C program to find the Square of a number (1 to 10) using Look-Up Table.
4	Write an 8051 C program to count the number of Ones and Zeros in two consecutive memory locations.
	III. Hardware Interfacing Programs
1	Write an 8051C Program to rotate stepper motor in Clock & Anti-Clockwise direction.
2	Write an 8051C program to Generate Sine &Square wave forms using DAC interface.
3	Develop Testing and experimental procedures on 8051Microcontroller, Analyze their operation under different cases.
4	Develop programs for 8051Microcontroller to implement real world problems.
5	Develop Microcontroller applications using external hardware interface.

4. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description

1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of microcontroller's concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

5. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Data Transfer Programs	Theory Session: Explain in brief the concepts related to data transfer operations, such as MOV, XCH, and PUSH/POP instructions. Explain the purpose of data transfer operations and their significance in programming tasks. Demonstration: Demonstrate examples of data transfer operations using assembly language Hands-On Exercises: Assign a series of hands-on exercises that involve writing assembly language programs to perform various data transfer tasks, such as: Transferring data between registers. Moving data between memory locations. Exchanging data between memory and I/O ports. Pushing and popping data from the stack.
2	Week 3-4 Arithmetic & Logical Operation Programs	Theory Session: Explain in brief the concepts related to arithmetic and logical operations, emphasizing their importance in microcontroller programming. Explain the types of arithmetic operations (addition, subtraction, multiplication, division) and logical operations (AND, OR, XOR, shift, rotate). Demonstration: Demonstrate examples of arithmetic and logical operations. Hands-On Exercises: Writing assembly language programs to add, subtract, multiply, and divide numbers stored in registers and memory. Implement logical operations such as AND, OR, XOR on data bytes and bits.
3	Week 5-6 Counter Operation Programs:	Theory Session: Explain in brief the concepts related to Counter operations, utilizing the timer/counter features of the 8051 microcontroller. 8051 Timer/Counter Registers: Learn about the special function registers (SFRs) related to timer/counters in the 8051 architecture. These include registers like TMOD (Timer Mode Control), TCON (Timer Control), TH0/TL0 and TH1/TL1 (Timer 0 and Timer 1 High/Low bytes), etc. Demonstration: Demonstrate examples of Counter Operation using assembly language Hands-On Exercises: Assign a series of hands-on exercises that involve writing assembly language programs to perform various operations such as Decimal UP-DOWN Counter and Hexadecimal UP-DOWN Counter using

		timer/counters in the 8051.
4	Week 7-8 C Programming	Theory Session: Explain in brief the concepts related to C programming. Demonstration: Demonstrate examples of simple C programmes Hands-On Exercises: Assign a series of hands-on exercises that involve Writingan8051 C program to find the sum of first 10 Integer Numbers, C program to find Factorial of a given number, C program to find the Square of a number(1 to 10)using Look-Up Table and C program to count the number of Ones and Zeros in two consecutive memory locations.
5	Week 9-10-11-12: Hardware Interfacing Programs	Theory Session: Explain in brief the concepts related to Introduction to Hardware Interfacing which involves connecting external devices to the microcontroller to extend its functionality. Discuss the importance of hardware interfacing in embedded systems and its applications in real-world projects. Explain the concept of ports and pins in the 8051 microcontroller. Explain how ports are used for interfacing with external devices, and how each port consists of individual pins that can be configured as inputs or outputs. Discuss the SFRs (Special Function Registers) related to port configuration, such as P0, P1, P2, and P3. Discuss analog sensors such as light sensors, temperature sensors, or potentiometers. Demonstration: Demonstrate simple input and output operations using LEDs and push buttons connected to the microcontroller's ports. Demonstrate reading sensor data and performing simple tasks based on sensor inputs. Hands-On Exercises: Write and execute basic programs to read input from switches and control output to LEDs using polling or interrupt-driven methods. Write and execute basic programs using digital sensors such as temperature sensors, motion sensors, or proximity sensors With the 8051 microcontroller using digital input/output ports. Write and execute basic programs for Interfacing with Analog Sensors with the 8051 microcontroller using analog-to-digital converters (ADCs) and Digital to Analog converters.

6. Assessment Details (both CIE and SEE)

CIE Split up for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30 marks (60% of the maximum Marks)

Laboratory Test: -B

CIE Split up for Test in Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20 marks (40% of the maximum Marks)

Final CIE for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record/journal-A	60% of the maximum	30
2	Scaled Down marks of test-B	40% of the maximum	20
Total		**100%**	**50**

Final CIE Marks =(A) + (B)

Semester End Examinations:

1. SEE marks for practical course shall be 50 marks

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20

2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding microprocessor and Microcontroller and embedded microcontrollers	Students will learn the difference between Microprocessor and Microcontroller and embedded microcontrollers.
2	Architecture of 8051microcontroller	Students will learn and analyze the architecture of 8051 microcontroller.
3	Programing 8051	Students will become proficient in writing Program for 8051 microcontroller using Assembly Language and C.
4	Timers/Counters and Serial port of 8051	Students will learn and analyze the operation and use of inbuilt Timers/Counters and Serial portof8051
5	I/O ports of 8051	Students will become proficient in using theinterruptstructureof8051 and Interfacing I/O devices using I/O ports of 8051.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge to design and implement, simulate, and verify complex embedded systems, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

CO's	DESCRIPTION OF THE OUTCOMES
M23BEC 309C.1	Apply the knowledge of 8051 Microcontrollers to write Assembly level/C language/ Hardware Interfacing programs for various applications.
M23BEC 309C.2	Conduct the experiments either individually or in team.
M23BEC 309C.3	Present experimental results/process both orally and in written form.

CO No	PO No												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
M23BEC 309C.1	3	-	-	-	-	-	-	-	-	-	-	-	3	2
M23BEC 309C.2	-	-	-	3	3	-	-	-	3	-	-	-	-	-
M23BEC 309C.3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BEC 309C	3	-	-	3	3	-	-	-	3	3	-	-	3	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Module 1	**12**			**12**
Module 2		**13**		**13**
Module 3			**15**	**15**
Module 4	**5**			**5**
Module 5		**5**		**5**

Total	**17**	**18**	**15**	50

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Module 1	**24**			
Module 2		**26**		
Module 3			**30**	
Module 4		**10**		
Module 5	**10**			
Total	**34**	**36**	**60**	100

10. Future with this Subject

The future scope of microcontrollers is vast and dynamic, driven by advancements in technology and the increasing demand for embedded systems across various industries. Here are some key areas where microcontrollers are expected to play a significant role in the future:

- Internet of Things (IoT) Applications: Microcontrollers will continue to be the backbone of IoT devices, enabling connectivity and intelligence in a wide range of applications such as smart homes, wearable's, industrial monitoring systems, and smart cities.
- Edge Computing: With the growing need for real-time data processing and reduced latency, microcontrollers will be utilized for edge computing tasks, enabling devices to process data locally without relying solely on cloud servers.
- Artificial Intelligence (AI) at the Edge: Microcontrollers are increasingly being equipped with AI capabilities, allowing them to perform tasks such as image recognition, natural language processing, and predictive analytics directly on the device, without needing to rely on cloud-based AI services.
- Low-Power Devices: As the demand for battery-powered and energy-efficient devices continues to rise, microcontrollers will evolve to become even more power-efficient while still providing sufficient processing power for various applications.
- Security: With the proliferation of connected devices and the increasing threat of cyber-attacks, microcontrollers will incorporate more robust security features to ensure the integrity and confidentiality of data transmitted and processed by these devices.
- Customization and Flexibility: Microcontrollers will offer more customization options, allowing developers to tailor them to specific application requirements, whether it's through programmable logic, configurable peripherals, or software-defined functionalities.
- Integration with Sensors and Actuators: Microcontrollers will continue to integrate seamlessly with a wide array of sensors and actuators, enabling the development of sophisticated systems for automation, robotics, and environmental monitoring.
- Medical Devices and Healthcare: Microcontrollers will play a crucial role in the development of wearable health monitoring devices, implantable medical devices, and other healthcare-related applications, contributing to advancements in telemedicine and personalized healthcare.

3rd Semester	Ability Enhancement Course (AE-III) SPREAD SHEET FOR ENGINEERS	M23BEC309D

1. Prerequisites:

S/L	Proficiency	Prerequisites
1.	Basic Computer Literacy	Ability to use a mouse and keyboard comfortably. Navigate folders and files on a computer
2.	Familiarity with Basic Office Applications	Prior experience with word processing software (e.g., Word, Pages) may be helpful for understanding basic formatting concepts. Understanding of basic operating system functions like opening, saving, and closing programs.
3.	Math Skills	Familiarity with basic mathematical operations (addition, subtraction, multiplication, division) Engineering calculations encountered in your coursework.
4.	Proficiency in intermediate-level skills.	Interest in exploring automation and optimization techniques
5.	Attention to Detail	Ability to follow instructions carefully and enter data accurately, which is crucial for technical tasks.

2. Competencies:

S/L	Competency	KSA Description
1.	Effective charts for engineering data	**Knowledge:** Chart types (XY scatter, line, bar, etc.) - Dual Y-axis charts - Error bars for data uncertainty. **Skills:** Selecting appropriate chart types for data representation. Adding error bars to visualize data variability. Creating combination charts to communicate multiple insights **Attitudes:** Attention to detail in chart design Critical thinking to choose charts that effectively convey engineering data Openness to explore different chart types for optimal communication
2.	Essential data analysis	**Knowledge:** Common statistical functions (SUM, AVERAGE, COUNT, MAX, MIN) Weighted averages for non-uniform data sets Trigonometric and exponential functions for engineering calculations Unit conversion using CONVERT function **Skills:** Applying relevant functions to analyze engineering data sets. Performing calculations specific to engineering disciplines. Utilizing unit conversion tools for accurate data analysis **Attitudes:** Problem-solving approach to data analysis - Analytical thinking to interpret calculated results - Adaptability to apply functions to various engineering problems.
3.	Conditional formatting and formulas for decision making	**Knowledge:** Logical operators (AND, OR, NOT) Conditional formatting rules (highlighting, data bars) IF statements for creating conditional logic VLOOKUP function for data lookup and retrieval. **Skills:** Building logical expressions for data analysis Implementing conditional formatting to highlight key data points Creating IF statements to automate decision-making within spreadsheets Utilizing VLOOKUP for efficient data retrieval in engineering contexts. **Attitudes:** Analytical skills to identify patterns and trends in data Resourcefulness in applying conditional logic and VLOOKUP to solve engineering problems
4.	Regression models for	**Knowledge:** Trendline concepts (slope, intercept) Interpolation and forecasting using trendlines

	engineering data	The LINEST function for linear regression Understanding residuals in regression analysis **Skills:** Fitting trendlines to data and interpreting slope and intercept - Utilizing regression analysis to make predictions based on engineering data - Analyzing residuals to assess the accuracy of the model **Attitudes:** Problem-solving skills to identify relationships within data Critical thinking to interpret regression results and their limitations Interest in exploring advanced regression techniques for diverse engineering applications
5.	Iterative solutions using Excel tools	**Knowledge:** Goal Seek for single-variable optimization Solver for finding roots of equations and optimization problems Understanding minimization and non-linear regression analysis **Skills:** Utilizing Goal Seek for targeted value adjustments Applying Solver for finding optimal solutions in engineering problems Employing Solver for root-finding and non-linear regression tasks **Attitudes:** Analytical thinking to identify optimization problems in engineering Persistence and problem-solving skills to navigate iterative solutions Interest in exploring advanced optimization techniques using Solver
6.	Basic matrix operations for engineering applications	**Knowledge:** Matrix addition, multiplication, and transposition Inverting matrices and solving linear equations using Excel tools **Skills:** Performing basic matrix operations relevant to engineering problems Utilizing Excel tools for matrix-based calculations **Attitudes:** Curiosity to explore advanced mathematical concepts applicable in engineering Adaptability to learn new tools for complex engineering calculations
7.	User-defined functions (UDFs) and macros for automation	**Knowledge:** Introduction to VBA programming (IF statements, loops) Building UDFs for custom calculations - Recording and editing macros **Skills:** Understanding basic VBA concepts for automating repetitive tasks Implementing UDFs to extend spreadsheet functionalities Creating and customizing macros to streamline workflows **Attitudes:** Initiative to explore advanced automation techniques Problem-solving approach to identify opportunities for automation in engineering spreadsheets Interest in learning VBA programming for enhanced spreadsheet capabilities

3. Syllabus

SPREAD SHEET FOR ENGINEERS SEMESTER – III			
Course Code	**M23BEC309D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**12 Sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**02**

Course objectives: This course will enable students to:

- Create informative visualizations with error bars for engineering data.
- Perform essential data analysis calculations relevant to engineering.
- Utilize conditional formatting and formulas for data-driven decision making in engineering.
- Develop and interpret regression models to analyze engineering data.
- Implement iterative solutions for engineering problems using Excel's Goal Seek and Solver tools.
- Explore matrix operations and VBA for automation

Experiments

1.	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2.	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3.	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR functions.
4.	Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
5.	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver.
6.	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Slope and Tangent, Analysis ToolPack.
7.	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure.
8.	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection.
Demonstration Experiments (For CIE only – not to be included for SEE)	
1.	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
2.	Differential Equations: Euler's Method, Modified Euler's Method, The RungeKutta Method, Solving a Second Order Differential Equation

Resources:

Excel Resources - 600+ Self Study Guides, Articles & Tools (wallstreetmojo.com)
McFedriesPaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition
https://www.ictlounge.com/html/year_7/esafety_part7.htm
https://chandoo.org/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction and Experiment-01	Introduction to Excel (Spread Sheets) Charting and different types of charts with suitable examples.
2	Week 3-4: Experiment-02 & Experiment-03	Exploring into various types of functions. Conditional functions: (IF, AND, OR)
3	Week 5-6: Experiment-04 & Assesment-01	Matrix Operations Using Excel Assessment-01 to be scheduled after the completion of 4 experiments.
4	Week 7-8: Experiment-05 & Experiment-06	Iterative Solutions Using Excel. Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function.
5	Week 9-10: Experiment-07 & Experiment-08	VBA User-Defined Functions (UDF) VBA Subroutines or Macros
6	Week 11-12: Demonstration Experiment-01, Demonstration Experiment- 02 & Assessment -02	Numerical Integration Using Excel Differential Equations Assessment-02 to be scheduled after the completion of all experiments.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Case Studies	Real-world engineering problems using spreadsheets (e.g., data analysis, financial calculations).
3	Projects	Utilize spreadsheets throughout project lifecycle (data, analysis, visualization).
4	Flipped Classroom	Pre-recorded lectures, in-class activities for applying concepts.
5	Collaboration	Teamwork using spreadsheets to solve engineering problems.

6	Self-Assessment & Reflection	Incorporating quizzes or prompts for students to assess their learning and reflect on areas for improvement.
7	Gamification	Games & challenges to enhance engagement (e.g., data analysis competitions).
8	Blended Learning	Combine classroom instruction with online resources (tutorials, quizzes).
9	Guest Lectures	Industry professionals share real-world spreadsheet applications in engineering.

6. 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 (CIE):

- CIE marks for the practical course are 50 Marks.
- The split-up of CIE marks for record and test are in the ratio 60:40.

Class Work: -A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30marks (60% of the maximum Marks)

Laboratory Test: -B

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to **20marks** (40% of the maximum Marks)

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record/journal-A	60% of the maximum	30
2	Scaled Down marks of test-B	40% of the maximum	20
Total		**100%**	**50**

Final CIE Marks =(A) + (B)

Semester End Evaluation (SEE):

1. SEE marks for the practical course shall be 50 marks

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
4. Duration of SEE shall be 2 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Create informative visualizations of engineering data	Students will be able to construct and interpret various chart types (XY scatter, dual Y-axis, combination) incorporating error bars to effectively communicate engineering data and uncertainties.
2	Perform essential data analysis calculations	Students will be proficient in applying common statistical functions (SUM, AVERAGE, COUNT, MAX, MIN) and engineering-specific calculations (trigonometric, exponential) using spreadsheets. Additionally, they will be able to utilize the CONVERT function for unit conversion within their analyses.
3	Utilize conditional formatting and	Students will be able to build logical expressions with AND, OR, and NOT operators. They will effectively implement conditional formatting rules to highlight key data points and create IF statements to automate decision-making

	formulas for data-driven decisions	within spreadsheets relevant to engineering contexts. VLOOKUP functionality will be employed for efficient data retrieval in engineering applications.
4	Develop and interpret regression models for engineering data	Students will be able to fit trendlines to engineering data sets, interpret the slope and intercept for understanding relationships. They will utilize the LINEST function for linear regression and analyze residuals to assess the accuracy of the model in predicting engineering outcomes.
5	Implement iterative solutions for engineering problems	Students will be able to leverage Excel's Goal Seek tool for single-variable optimization and the Solver tool to find roots of equations and perform optimization tasks relevant to engineering problems, Explore basic matrix operations for specific engineering applications.
6	Develop user-defined functions (UDFs) and macros for automation	Students will be introduced to basic VBA programming concepts for automating repetitive tasks encountered in engineering workflows. This may include building UDFs for custom calculations and creating macros to streamline data processing tasks. (Optional: Design user forms for improved data input and interaction.)

8. Course Outcomes (COs) and Mapping with POs/ PSOs:

Course Outcomes (COs):

COs	Description
M23BEC309D.1	Illustrate advanced proficiency in Excel, mastering data analysis and visualization through creating XY scatter graphs, Functions, Regression Analysis
M23BEC309D.2	Apply iterative solutions with Goal Seek and Solver, solve linear equations using matrix operations, and automate tasks through VBA user-defined functions and macros and document the same.
M23BEC309D.3	Analyze a wide range of functions, including statistical computations, weighted averages, trigonometric and exponential functions, and conditional functions for data-driven decisions.

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC309D.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC309D.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC309D.3	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC309D	3	3	-	-	-	-	-	-	-	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Total	**14**	**18**	**18**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Total	**20**	**40**	**40**	**100**

SEE for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks

10. Future with this Subject

For engineering students, spread sheets have been the trusty companions for calculations, data analysis, and even the occasional project plan. But the future holds exciting possibilities that will transform these workhorses into powerful tools for tackling complex engineering challenges. Here's a sneak peek at what's on the horizon:

1. No More Data Drudgery: Seamless Integration and Smart Automation

- Imagine a world where your spreadsheet seamlessly pulls data from specialized engineering software. No more endless copy-pasting – just a smooth flow of information between your tools.
- Forget repetitive tasks like data cleaning and formula selection. AI-powered features will automate these processes, freeing you to focus on the real engineering magic – analyzing results, interpreting trends, and coming up with innovative solutions.

2. Collaboration Without Borders: Cloud Takes Over

- Forget emailing endless spreadsheet versions back and forth. Cloud-based solutions will allow you to work on projects simultaneously with classmates and professors in real-time, no matter the location. This opens the door for brainstorming sessions and problem-solving on a global scale.

3. Data Visualization Gets a Makeover: From Charts to Stories
    - Move over, boring bar charts! Interactive dashboards will become the norm, allowing you to create stunning visuals that tell a compelling story about your engineering data. Imagine captivating presentations and reports that leave a lasting impression!
4. Industry-Specific Superpowers: Spread sheets Tailored to Your Discipline
    - The future holds specialized add-ons for different engineering disciplines. These add-ons will provide tailored functionalities that address your specific engineering needs.
5. Security First: Protecting Your Engineering Data
    - As spread sheets handle increasingly sensitive engineering data, security will be paramount. Features like access control, version control, and audit trails will become essential for ensuring data integrity and compliance with regulations.
6. Coding: Not Necessary: Low-Code/No-Code Development for Everyone
    - Even without extensive programming knowledge, you might be able to build custom engineering applications or automate workflows directly within the spreadsheet environment. These low-code/no-code development features will empower you to tailor your spread sheets for maximum efficiency and innovation.

3rd Semester	Non Credit Mandatory Course (NCMC) NATIONAL SERVICE SCHEME (NSS)	M23BPEK310

NATIONAL SERVICE SCHEME (NSS)
SEMESTER-III

Course Code	**M23BNSK310**		
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**

Activities Report Evaluation by College NSS Officer at the end of every semester (3rd to 6th semester)

Course objectives:

National Service Scheme (NSS) will enable students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem –solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions - Pedagogy:

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for NSS activities and its present relevance in the society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Contents:

1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.
2. Waste management– Public, Private and Govt organization, 5 R's.
3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4. Water conservation techniques – Role of different stakeholders– Implementation.
5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.
7. Developing Sustainable Water management system for rural areas and implementation approaches.
8. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swatch Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
9. Spreading public awareness under rural outreach programs. (minimum5 programs).
10. Social connect and responsibilities.
11. Plantation and adoption of plants. Know your plants.
12. Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).
13. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Distribution of Activities - Semester wise from 3rd to 6th semester

NOTE:
1. Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
2. At the end of every semester, activity report should be submitted for evaluation.

Sem	Topics / Activities to be Covered
3rd Sem for 25 Marks	1. Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing. 2. Waste management– Public, Private and Govt organization, 5 R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4th Sem for 25 Marks	Water conservation techniques – Role of different stakeholders– Implementation. Preparing an actionable business proposal for enhancing the village income and approach for implementation. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.
5th Sem for 25 Marks	1. Developing Sustainable Water management systems for rural areas and implementation approaches. 2. Contribution to any national-level initiative of the Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. 3. Spreading public awareness under rural outreach programs. (minimum 5 programs). 4. Social connect and responsibilities.
6th Sem for 25 Marks	1. Plantation and adoption of plants. Know your plants. 2. Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs). 3. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Course outcomes (Course Skill Set):

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

M23BNSK310.1: Understand the importance of his / her responsibilities towards society.

M23BNSK310.2: Analyse the environmental and societal problems/issues and will be able to design solutions for the same.

M23BNSK310.3: Evaluate the existing system and to propose practical solutions for the same for sustainable development.

M23BNSK310.4: Implement government or self-driven projects effectively in the field.

M23BNSK310.5: Develop capacity to meet emergencies and natural disasters & practice nationa integration and social harmony in general.

Pedagogy–Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic differences, location, and time of execution.

Sl. No.	Topic	Group size	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for Marketing.	May be individual or team	Farmers land/ Villages/ roadside/ community area /College campus etc.	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govt organization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers campus etc…	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus etc…	Group selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Site selection / Proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages / City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Group selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
6.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	School selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
8.	Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers /campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
9.	Spreading public awareness under rural outreach programs. (minimum5 programs). ///// Social connect and responsibilities.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

10.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
11.	Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
2.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be an individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus etc…	Place selection / proper consultation/ Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

Plan of Action ((Execution of Activities for Each Semester)

Sl. No	Practice Session Description
1.	Lecture session by NSS Officer
2.	Students' Presentation on Topics
3.	Presentation - 1, Selection of topic, PHASE – 1
4.	Commencement of activity and its progress - PHASE - 2
5.	Execution of Activity
6.	Execution of Activity
7.	Execution of Activity
8.	Execution of Activity
9.	Execution of Activity
10.	Case study-based Assessment, Individual performance
11.	Sector-wise study and its consolidation
12.	Video-based seminar for 10 minutes by each student At the end of the semester with a Report.

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last in the 6th semester consolidated report of all activities from the 3rd to 6th semester, compiled report should be submitted as per the instructions.

Assessment Details:

Weightage	**CIE– 100%**
Presentation - 1 Selection of topic, PHASE - 1	**10 Marks**
Commencement of activity and its progress - PHASE - 2	**10 Marks**
Case Study - based Assessment Individual Performance with Report	**10 Marks**
Sector-wise study & its consolidation	**10 Marks**

- Implementation strategies of the project (NSS work).
- The last Report should be signed by the NSS Officer, the HOD, and the principal.
- At last Report should be evaluated by the NSS officer of the institute.
- Finally, the consolidated marks sheet should be sent to the university and made available at the LIC visit.

Video based seminar for 10 minutes by each student At the end of semester with Report. Activities.	**10 Marks**	
Total marks for the course in each semester	**50 Marks**	
Marks scored for 50 by the students should be Scale down to 25 marks In each semester for CIE entry in the VTU portal.		
25 marks CIE entry will be entered in University IA marks portal at the end of each semester 3rd to 6th sem, Report and assessment copy should be made available in the department semester wise		
Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society in general.		
Suggested Learning Resources: **Books** : 1. NSS Course Manual, Published by NSS Cell, VTU Belagavi. 2. Government of Karnataka, NSS cell, activities reports and manual. 3. Government of India, NSS cell, Activities reports and manual.		

3rd Semester	Non Credit Mandatory Course (NCMC) PHYSICAL EDUCATION (SPORTS & ATHLETICS)	M23BPEK310

PHYSICAL EDUCATION (SPORTS& ATHLETICS)

SEMESTER-III

Course Code	**M23BPEK310**	CIE Marks	**100**
Number of Lecture Hours/Week(L: T: P: S)		SEE Marks	
Total Number of Lecture Hours		Total Marks	**100**
Credits	**0**	Exam Hours	**-**

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

M23BPEK310.1: Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness.

M23BPEK310.2: Familiarization of health-related Exercises, Sports for overall growth and development.

M23BPEK310.3: Create a foundation for the professionals in Physical Education & Sports.

M23BPEK310.4: Participate in the competition at regional/state / national / international levels.

M23BPEK310.5: Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.

Module-1

Orientation **(5hours)**

A. Lifestyle
B. Fitness
C. Food & Nutrition
D. Health &Wellness
E. Pre-Fitness test.

Module-2

General Fitness & Components of Fitness: **(15hours)**

A. Warming up (Free Hand exercises)
B. Strength — Push-up / Pull-ups
C. Speed — 30 Mtr Dash
D. Agility — Shuttle Run
E. Flexibility — Sit and Reach
F. Cardiovascular Endurance — Harvard step Test

Module-3

Recreational Activities: **(10hours)**

A. Postural deformities.
B. Stress management.
C. Aerobics.
D. Traditional Games.

Scheme and Assessment for auditing the course and Grades:

Sl. No.	Activity	Marks
1.	Participation of student in all the modules	**20**
2.	Quizzes — 2, each of 15 marks	**30**
3.	Final presentation/exhibition / Participation in competitions/practical on specific tasks assigned to the students	**50**
	Total	**100**

3rd Semester	Non Credit Mandatory Course (NCMC) YOGA	M23BYOK310

YOGA
SEMESTER-III

Course Code	**M23BYOK310**		
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**

Evaluation Method: Objective type
Theory / Practical / Viva- Voice

Course objectives:

1. To enable the student to have good Health.
2. To practice mental hygiene.
3. To possess emotional stability.
4. To integrate moral values.
5. To attain a higher level of consciousness.

The Health Benefits of Yoga

The benefits of various yoga techniques have been supposed to improve

- body flexibility,
- performance,
- stress reduction,
- attainment of inner peace, and
- self-realization.

The system has been advocated as a complementary treatment to aid the healing of severalailments such as

- coronary heart disease,
- depression,
- anxiety disorders,
- asthma, and extensive rehabilitation for disorders including musculoskeletal problems and traumatic brain injury.

The system has also been suggested as behavioral therapy for smoking cessation and substanceabuse (including alcohol abuse).

If you practice yoga, you may receive these physical, mental, and spiritual benefits:

- Physical
  1. Improved body flexibility and balance
  2. Improved cardiovascular endurance (stronger heart)
  3. Improved digestion
  4. Improved abdominal strength
  5. Enhanced overall muscular strength
  6. Relaxation of muscular strains
  7. Weight control
  8. Increased energy levels
  9. Enhanced immune system

Mental

1. Relief of stress resulting from the control of emotions
2. Prevention and relief from stress-related disorders
3. Intellectual enhancement, leading to improved decision-making skills

- Spiritual
  1. Life with meaning, purpose, and direction
  2. Inner peace and tranquillity
  3. Contentment

Yoga Syllabus

Semester III

- Yoga, its origin, history and development. Yoga, its meaning, definitions.
- Different schools of yoga, Aim and Objectives of yoga, importance of prayer
- Yogic practices for a common man to promote positive Health
- Rules to be followed during yogic practices by the practitioner
- Yoga its misconceptions,
- Difference between yogic and non-yogic practices

- Surya namaskar prayer and its meaning, Need, importance and benefits of Surya namaskar 12 count, 2rounds
- Asana, Need, importance of Asana. Different types of asanas. Asana its meaning by name, technique,precautionary measures and benefits of each asana
- Different types of Asanas
  a. Sitting
     1. Padmasana
     2. Vajrasana
  b. Standing
     1. Vrikshana
     2. Trikonasana
  c. Prone line
     1. Bhujangasana
     2. Shalabhasana
  d. Supine line
     1. Utthitadvipadasana
     2. Ardhahalasana

Semester IV

- Patanjali's Ashtanga Yoga, its need and importance.
- Yama : Ahimsa, satya, asteya, brahmacarya, aparigraha.
- Niyama : shoucha, santosh, tapa, svaadhyaya, Eshvarapranidhan
- Suryanamaskar12 count- 4 rounds of practice
- Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique,precautionary measures and benefits of each asana.

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

- Understand the meaning, aim and objectives of Yoga.
- Perform Suryanamaskar and able to Teach its benefits.
- Understand and teach different Asanas by name, its importance, methods and benefits.
- Instruct Kapalabhati and its need and importance.
- Teach different types of Pranayama by its name, precautions, procedure and uses

Coach different types of Kriyas , method to follow and usefulness.

Assessment Details (both CIE and SEE)

- Students will be assessed with internal test by a. Multiple choice questions b. Descriptive type questions (Two internal assessment tests with 25 marks/test)
- Final test shall be conducted for whole syllabus for 50 marks.
- Continuous Internal Evaluation shall be for 100 marks (including IA test)

Suggested Learning Resources:
Books:
1. Yogapravesha in Kannada by Ajitkumar
2. Light on Yoga by BKS Iyengar
3. Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly
4. Yoga Instructor Course hand book published by SVYASA University, Bengaluru
5. Yoga for Children –step by step – by Yamini Muthanna

Web links and Video
Lectures (e-Resources):
Refer links
1. https://youtu.be/KB-TYlgd1wE
2. https://youtu.be/aa-TG0Wg1Ls

3rd Semester	Basic Science Course (BS) DIPLOMA MATHEMATICS-I	M23BDIPM311

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Calculus	Knowledge of calculus, specifically Successive differentiation-problems.
2	Basic Concepts Of Complex Numbers	Strong knowledge of Complex Numbers, to solve differential equations.
3	Basic Mathematics	Knowledge of advanced calculus, and ordinary differential equations Familiarity with identify the dependent and independent variables
4	Basic Concept of Vector Algebra and Vector Differentiation	Knowledge of basics, solving Mechanical engineering problems using vector calculus.
.5	Previous Coursework	Completion of introductory courses for ME Stream or a related field

2. Competencies

S/L	Competency	KSA Description
1	Differential Calculus:	**Knowledge**: Introduction to of basics of Successive differentiation **Skills**: Total derivatives-differentiation of composite functions. Jacobians of order two Problems Analysis of probabilistic models. **Attitudes:** Applications to Mathematical Quantities of Partial Differentiation.
2	Complex Numbers:	**Knowledge:** Basic concept of Complex Numbers. **Skills:** Solving ordinary differential equations arising in Engineering applications. **Attitudes:** Appreciation for using ordinary differential equation in Vibration of a rod/ membrane.
3	Vector Differentiation	**Knowledge:** Understanding of basic operations on vector calculus **Skills:** Apply to the heat and mass transfer, oil refinery problems, environmental engineering, **Attitudes:** Appreciation for velocity and acceleration of moving particles, analysis of streamlines.
4	Integral Calculus	**Knowledge**: Understanding of basic solution of algebraic and transcendental equations: **Skills:** Solve mechanical engineering problems involving Integral Calculus in Engineering analysis. **Attitudes:** Solutions to solve mechanical engineering problems involving Integral Calculus.
5	Ordinary Differential Equations (ODEs):	**Knowledge**: Understanding of basics ordinary differential equations of first order and first degree **Skills**: Solving ordinary and partial differential equations arising in engineering applications, using numerical methods **Attitudes:** Finding approximate solutions to solve mechanical engineering problems.

3. Syllabus

DIPLOMA MATHEMATICS-I SEMESTER–III			
Course Code	**M23BDIPM311**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:0:0)**	SEE Marks	
Total Number of Lecture Hours	**20 Theory**	Total Marks	**50**
Credits	**0**	Exam Hours	**00**
Course objectives: This course will enable students to: The mandatory learning course M23BDIPM311 viz., Additional Mathematics-I aims to provide basic concepts of complex numbers, vector algebra, differential & integral calculus, vector differentiation, and methods of solving first-order differential equations.			
Module -1 Differential Calculus: (8 hours)			

Successive differentiation-problems. Taylor's & Maclaurin's series Expansions-problems. Partial Differentiation: Euler's theorem (without Proof)-problems on first-order derivatives only. Total derivatives-differentiation of composite functions. Jacobians of order Two problems.	L1, L2, L3
Module -2 Complex Numbers: (8 hours)	
Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof), Problems. Vector Algebra: Scalar and vectors. Addition, subtraction, and multiplication of vectors- Dot and Cross products, problems. Scalar triple product, Problems.	L1, L2, L3
Module -3 Vector Differentiation: (8 hours)	
Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl-simple problems. Solenoidal and irrotational vector fields-Problems.	L1, L2, L3
Module -4 : Integral Calculus: (8 hours)	
Review of elementary integral calculus. Reduction formulae for sinx, $\cos^n x$, $\sin^n x \cos^n x$ (without proof) and evaluation of these with standard limits-problems. Double and triple integrals-Simple problems.	L1, L2, L3
Module -5 Ordinary Differential Equations (ODEs): (8 hours)	
Introduction-solutions of first order and first-degree differential equations: Variable separable method, Homogeneous differential equations, linear differential equations. Exact differential equations.	L1, L2, L3

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Differential Calculus:	Successive differentiation-problems. Taylor's & Maclaurin's series expansions-problems. Partial Differentiation: Euler's theorem (without Proof)-problems on first-order derivatives only. Total derivatives-differentiation of composite functions. Jacobians of Order Two-Problems.
2	Week 3-4: Complex Numbers	Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof), Problems. Vector Algebra: Scalar and vectors. Addition, subtraction and multiplication of vectors- Dot and Cross products, problems. Scalar triple product, Problems.
3	Week 5-6: Vector Differentiation	Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl-simple problems. Solenoidal and irrational vector Fields-Problems.
4	Week 7-8: Integral Calculus	Review of elementary integral calculus. Reduction formulae for $\sin^n x$, $\cos^n x$, $\sin^n x \cos^m x$ (without proof) and evaluation of these with standard limits-problems. Double and triple integrals-Simple problems.
5	Week 9-10: Ordinary Differential Equations	Introduction-solutions of first order and first-degree differential equations: Variable separable method, Homogeneous differential equations, Linear differential equations. Exact differential equations.
6	Week 11-12: Applications	Applications of the above topics

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture formatto reinforce Competencies.
2	Video/Animation	In corporate visual aids like videos /animations to enhance Understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.

4	Higher Order Thinking(HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning(PBL)	Implement PBL to enhance analytical skills and practical application of Competencies
6	Multiple	Introduce topics in various representation store in force competencies
	Representations	
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to Facilitate deeper understanding of competencies

6. Assessment Details (both CIE and SEE)

1. CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE permitted to appear in the SEE of the course.
2 CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3. The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		**100 marks**

Semester End Examinations

5. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
6. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
7. The students have to answer 5 full questions selecting one full question from each module.
8. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Integral calculus and Vector differentiation and its Fundamentals	Students will learn the importance of Integral calculus and Vector differentiation essential for Mechanical engineering.
2	Understanding Fundamentals of ordinary Differential Equations	Students will formulate various mathematical models by using ordinary Differential Equations
3	Proficiency in complex numbers	Students will become proficient in solving complex numbers problems.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to Industry standard and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BDIPM311.1	Use derivatives and partial derivatives to calculate the rate of change of multivariate functions.
M23BDIPM311.2	Apply concepts of complex numbers and vector algebra to analyse the problems arising in a related area.

M23BDIPM311.3	Analyse position, velocity, and acceleration in two and three dimensions of vector-valued functions.
M23BDIPM311.4	Learn techniques of integration including the evaluation of double and triple integrals.
M23BDIPM311.5	Identify and solve first-order ordinary differential equations.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BDIPM311.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM311.2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM311.3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM311.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM311.5	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM311	3	3	-	-	-	-	-	-	-	-	-	-	-	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	10					10
Module 2		10				10
Module 3			10			10
Module 4				10		10
Module 5					10	10
Total	10	10	10	10	10	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	20					20
Module 2		20				20
Module 3			20			20
Module 4				20		20
Module 5					20	20
Total	20	20	20	20	20	100

10. Future with this Subject

The Additional Mathematics-I course in the third semester fifth B.E program a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

Calculus: use of calculus quite often in our daily lives. Various fields such as engineering, medicine, biological research, economics, architecture, space science, electronics, statistics, and pharmacology all benefit from the use of calculus.

Complex numbers Imaginary numbers or complex numbers are used in various fields such as: Signal processing: Imaginary numbers can also be applied to signal processing, which is useful in cellular technology and wireless technologies, as well as radar and even biology (brain waves).

Vector calculus: Vector calculus is further generalization of calculus to vectors and dedicated to resolve linear equations which applied to neural network is the model to reflect the operation of neural networks.

Ordinary differential equations: Differential equations describe various exponential growths and decays. ODE's are also used to describe the change in return on investment over time. ODE's are used in the field of medical science for modelling cancer growth or the spread of disease in the body.

4th Semester	Basic Science Course (BS) BIOLOGY FOR ENGINEERS	M23BBIOK401

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Knowledge of Biology	A basic understanding of high school-level biology concepts can be beneficial. This includes knowledge of cell structure, basic physiology, and fundamental biological processes.
2.	Basic Knowledge of Biochemistry	Familiarity with major biological molecules and their application (carbohydrates, proteins, lipids, nucleic acids, vitamins, enzymes, and hormones).
3.	Basic Knowledge of Mathematics and Physics	Understanding the human anatomy and physiological systems in comparison with bioengineering principles.
4.	Basic Concepts of Design	Understanding of basic design and system thinking, which will help in bioengineering design and nature-bioinspired materials and mechanisms?
5.	Engineering Fundamentals	Ability to analyze and apply basic engineering principles to solve biological problems.

2. Competencies

S/L	Competency	KSA Description
1.	Cell Structureand Function	**Knowledge**: Understand the fundamentals of Cell Biology **Skills:** Efficient file manipulation, text pro. **Attitudes:** Appreciate the complexity and diversity of cellular structures. Demonstrate an interest in how biomolecules contribute to lifeprocesses.
2.	Biomolecules	**Knowledge**: Understanding the applications of Biomolecules. **Skills:** Analyze and apply the knowledge of Biomolecules. **Attitudes:** Demonstrate an interest in how biomolecules contribute to lifeprocesses
3.	Anatomical Principles for Bioengineering Design	**Knowledge:** Understanding the human anatomical administration. **Skills:** Apply knowledge of human anatomy to bioengineering projects **Attitudes:** Appreciate the ingenuity of biological systems and their engineering potential. Exhibit creativity in applying anatomical principles to engineering problems.
4.	Nature- Bio inspired Materials andMechanisms	**Knowledge:** Comprehend the principles behind bio inspired materials and mechanisms **Skills:** Analyze and apply knowledge of natural principles to design innovative materials and systems. **Attitudes:** Demonstrate curiosity about how natural systems work and their Potential applications. Exhibit a proactive approach to learning from nature to solve engineering challenges.
5.	Trends In Bioengineering	**Knowledge:** Comprehend the principles and applications behindbioengineering. **Skills:** Analyze and apply knowledge of bioengineering principles tounderstand various environmental and industrial contexts. **Attitudes:** Demonstrate curiosity about how natural systems work and theirpotential applications. Exhibit a proactive approach to learning from nature to solve Engineering challenges.

3. Syllabus

BIOLOGY FOR ENGINEERS SEMESTER – IV			
Course Code	**M23BBIOK401**	CIE Marks	**50**
Number of Lecture Hours/Week (L: T: P: S)	**1:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**15 hours Theory**	Total Marks	**100**
Credits	**01**	Exam Hours	**01**

Course objectives:

To acquaint the students with fundamental biological principles and their application to bioengineering.

To enable the students to understand the bio-design principles to create novel devices and structures.

To show the students how biological systems can be re-designed as substitute products for naturalsystems.

To encourage students to create an interdisciplinary view of biological engineering.

MODULE - 1 (3 Hours)	
CELL BIOLOGY Introduction to cell (Types, structure, and major functions of Cells and Cell Organelles) Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, Proteins, Lipids, Enzymes, Vitamins, and Hormones.	L1, L2, L3
MODULE 2 (3 Hours)	
BIOMOLECULES AND THEIR APPLICATION Carbohydrates as Cellulose-based water filters, PHA and PLA as Bio plastics, Nucleic acids in Vaccines and Diagnosis, Proteins in food production (Plant-based protein, Whey protein, and Meat analogs), Lipids as biodiesel, and cleaning agents/detergents, Enzymes in Biosensors fabrication, Food processing, Detergent formulation, and Textile processing.	L1, L2, L3
MODULE 3 (3 Hours)	
ADAPTATION OF ANATOMICAL PRINCIPLES FOR BIOENGINEERING DESIGN Brain as a CPU System. Eye as a Camera System. Heart as a Pump System. Lungs as Purification System. Kidney as a Filtration System.	L1, L2,L3
MODULE 4 (3 Hours)	
NATURE-BIOINSPIRED MATERIALS AND MECHANISMS Echolocation, Photosynthesis. Bird Flying, Lotus Leaf Effect, Plant Burrs, Sharkskin, Kingfisher Beak. Human Blood Substitutes - Hemoglobin-Based Oxygen Carriers (Hbocs) and Per fluoro carbons (Pfcs).	L1, L2, L3
MODULE 5 (3 Hours)	
TRENDS IN BIOENGINEERING: Scaffolds In Muscular, Skeletal Systems and Tissue Engineering, Bio printing Techniques and Materials. Electrical Tongue and Electrical Nose in Food Science, DNA Origami and Biocomputing, Bio imaging, and Artificial Intelligence for Disease Diagnosis. Bio concrete. Bioremediation. Bio mining.	L1, L2, L3

Text Book(s)

1. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.

2. 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.

Reference Books

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
2. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
3. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
4. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
5. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
6. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C.Mattiussi, MIT Press, 2008.
7. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A C Udayashankar Lambert Academic Publishing, 2019.
8. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
9. 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

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-2: Cell Biology	**Competency:** Understand cell biology and biomolecule functions. **Knowledge:** Understand and describe the types, structures, and major functions of cells and their organelles. **Skills:** Identify and describe the importance of the cell
2.	Week 3-5: Biomolecules andtheir Applications	**Competency:** Apply knowledge of biomolecules to real-worldapplications **Knowledge:** Understand the properties and functions of keybiomolecules: carbohydrates, nucleic acids, proteins, lipids, enzymes, vitamins, and hormones. **Skills:** Analyze the role of various biomolecules
3.	Week 6-8: Adaptation Of Anatomical Principles for Bioengineering Design	**Competency:** Translate anatomical principles into bioengineering designs. **Knowledge:** Understand anatomical principles to bioengineering designs, drawing analogies such as the brain as a CPU system, the eye asa camera system, the heart as a pump system, the lungs as a purification system, and the kidney as a filtration system. **Skills:** Analyze the role of human anatomy with bioengineering principles
4.	Week 9-10: Nature-Bio inspired Materials and Mechanisms	**Competency:** Utilize bio inspired materials and mechanisms. **Knowledge:** Understand and explain natural bio-inspired mechanisms. **Skills:** Apply knowledge of natural principles to design innovativematerials and systems.
5.	Week 11-12: Trends in Bioengineering	**Competency:** Keep abreast of current trends and technologies in bio engineering. **Knowledge:** Understand the principles and applications of various bio-engineering mechanisms. **Skills:** Apply knowledge of biology in engineering trends in various filed of science.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Explanation via real-life problems, situation modeling, deliberation of solutions, hands-on sessions, reflective and questioning /inquiry - based teaching.
2.	Live Demonstration	Instructions with interactions in classroom lectures (physical/hybrid).
3.	CollaborativeLearning	Encourage collaborative learning for improved competency application.
4.	ICT Tools	Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical applicationof competencies
6.	Multiple Representations	Introduce topics in various representations to reinforce competencies
7.	Gamification Tools	Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes
8.	Student Seminars	Solo, group /oral presentations.
9.	Model Making	Demonstration using working models.

6. Assessment Details (both CIE and SEE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

Final CIE for Theory based Ability Enhancement Course

Components		Number	Weightage	Max.	Min.
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
	Total Marks (A+B)			**50**	**20**

The CIE question paper shall have MCQ set for 25 questions, each carrying one mark.
Average internal assessment shall be the average of the 2 test marks conducted.
The SEE question paper shall have MCQ set for 50 questions, each carrying one mark. The time duration for SEE is one hour

7. Learning Objectives

S/L	Learning Objectives	Description
1.	Understanding the fundamentals of Cell	Students will understand the types, structures, and functions of cells and their organelles.
2.	Analyze the applicationof Biomolecules	Students will be able to analyze the practical applications of carbohydrates, proteins, nucleic acids, lipids, and enzymes.
3.	Bioengineered System Models	Students will be able to translate anatomical principles into bioengineering designs.
4.	Bio inspired Mechanism Models	Students will be able to explore and replicate nature-inspired materials and mechanisms.
5.	Emerging Bioengineering Technology Models	Students will be able to understand and demonstrate the latest trends in bioengineering.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

COs	Description
M23BBIOK401.1	Elucidate the fundamentals of biological concepts employing pertinent health, andengineering applications.
M23BBIOK401.2	Assess the biological ideologies for the design and development of novel bioengineering solutions.
M23BBIOK401.3	Substantiate and apply the ideologies amid nature-inspired biomimeticsperceptions for explicit engineering solutions.
M23BBIOK401.4	Exploring innovative bio-based solutions for relevant biological complications.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
M23BBIOK401.1	3	-	-	-	-	-	3	-	-	-	-	3	3	-
M23BBIOK401.2	3	-	3	-	-	3	-	-	-	-	-	3	-	-
M23BBIOK401.3	3	3	3	-	-	-	3	-	-	-	-	3	-	-
M23BBIOK401.4	3	-	3	-	3	-	3	-	-	-	-	-	-	-
M23BBIOK401	3	3	3	-	3	3	3	-	-	-	-	3	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	3	2	3	2	10
Total	13	12	13	12	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	5	5	5	5	20
Total	25	25	25	25	**100**

10. Future with this Subject

By equipping students with the knowledge, skills, and attitudes necessary to excel in bioengineering, the "Biology for Engineers" course prepares them for a future where they can make significant contributions to healthcare, environmental sustainability, and numerous other fields where biology and engineering intersect.

- Future Trends in Bioengineering

1. Personalized Medicine: Understanding genetics and molecular biology to designpersonalized medical treatments.
   Applications: Developing patient-specific drugs, gene therapy, and personalizedtreatment plans based on individual genetic profiles.
   Regenerative Medicine and Tissue Engineering: Studying stem cells, scaffoldingmaterials, and growth factors. Applications: Creating artificial organs, repairing damaged tissues, and developing bioengineered skin for burn victims.
2. Bio printing: Learning about 3D printing techniques and biomaterials.
   Applications: Printing tissues and organs, developing complex tissue structures for research and therapeutic use.
3. Synthetic Biology: Engineering biological systems for new functions.
   Applications: Designing microorganisms to produce biofuels, clean pollutants, or synthesize pharmaceuticals.
4. Biomedical Imaging and Diagnostics: Understanding imaging technologies anddiagnostic tools.
   Applications: Advancing MRI, CT scans, and other imaging technologies to improve diagnostic accuracy and patient outcomes.
5. Wearable Health Technologies: Integrating biology with electronics and materialsscience.
   Applications: Developing wearable devices that monitor health metrics, detect diseases early, and provide real-time health data to patients and doctors.
6. Artificial Intelligence in Healthcare: Combining biology with data science and machinelearning.
   Applications: Using AI to analyze complex biological data, predict disease outbreaks, and personalize medical treatments.
7. Environmental Bioengineering: Applying biological principles to environmentalchallenges.
   Applications: Bioremediation, bio mining, and developing sustainable agricultural practices.

➢ Career Paths for Bioengineers

1. Biomedical Engineer:
   Role: Design and develop medical devices, prosthetics, and diagnostic equipment.
   Skills: Combining engineering principles with biological knowledge to solvemedical problems.
2. Clinical Research Scientist:
   Role: Conduct research to improve medical technologies and treatment methods.
   Skills: Applying biological and engineering expertise to clinical trials andlaboratory research.
3. Biotech Product Manager:
   Role: Oversee the development and marketing of biotech products.
   Skills: Understanding both the technical aspects of bioengineering and thecommercial landscape.
4. Regenerative Medicine Specialist:
   Role: Focus on developing therapies that regenerate damaged tissues and organs.
   Skills: Combining knowledge of cell biology, biomaterials, and clinicalapplications.
5. Environmental Engineer:
   Role: Develop solutions for environmental problems using biological principles.
   Skills: Applying bioengineering techniques to waste management, pollution control, and sustainable development.
6. Bioinformatics Specialist:
   Role: Analyze biological data using computational tools.
   Skills: Merging biology with computer science to interpret complex data sets anddevelop new algorithms for biological research.
7. Bioprocess Engineer:
   Role: Design and optimize processes for producing biological products.
   Skills: Understanding both the biological and engineering aspects of bioproduction, including scaling up processes from lab to industry.
8. Academic Researcher/Professor:
   Role: Conduct research and teach at universities.
   Skills: Advancing knowledge in bioengineering and educating the next generationof engineers.

4th Semester	Professional Course (PC) ELECTROMAGNETIC WAVES	M23BEC402

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Vector analysis	Need a proper and complete understanding of vectors and Coordinate systems.
2.	Calculus	Integration and differentiation to understand derivations and numerals involved. Vector calculus including divergence, curl, and gradient.
3.	Electromagnetism	Understanding the physical interpretations of Electromagnetism basics, by Visualization and Imagination beyond the mathematics that is involved
4.	Conductors and capacitors	Understanding of current and current density. The capacitance of different capacitors.
5.	Courses	Physics, Mathematics, and Introduction to Electrical Engineering

2. Competencies

S/L	Competency	KSA Description
1.	Vectors and vector calculus	**Knowledge: U**nderstanding of vector algebra, dot product and cross product, vector calculus, and concepts such as Divergence, curl, and gradient of a vector. Familiarity with coordinate systems **Skills:** vector addition, subtraction, division, and multiplication, vector visualization in 3D, problem-solving skills in different coordinate systems **Attitudes:** creativity and critical thinking
2.	Electrostatics	**Knowledge: U**nderstanding of vector calculus. Knowledge of gauss law, energy, electric potential, conductors and capacitors. **Skills:** Calculation of electric field quantities by analyzing different charge configurations (charges at rest). **Attitudes:** Analyzing, applying and problem solving
3.	Magneto statics	**Knowledge:** understanding of Biot-savart's law, Amperes law, Magnetic energy and potential, Magnetic forces and materials **Skills:** Calculation of magnetic field quantities by analyzing static magnetic field. **Attitudes:** analyzing, applying and problem solving
4.	Boundary conditions	**Knowledge:** Reflection and transmission of waves, knowledge of Maxwell's equations and knowledge of different interfaces. **Skills:** Application of boundary conditions and analysis of wave propagation across two different media. **Attitudes:** Analyzing, applying and problem solving
5.	Time-varying Fields and Maxwell's Equation	**Knowledge:** Knowledge of mathematical and physics concepts such as vector calculus, differential equations to derive Maxwell's equations for different media. **Skills:** use of Vector calculus to interpret Maxwell's equations, ability to analyze Maxwell's equation suitable for given field. **Attitudes:** Analyze, apply and interpret.
6.	Uniform Plane Wave propagation	**Knowledge:** Understanding of Maxwell's equations, wave equation and characteristics of a wave. Solution of uniform plane wave. **Skills:** Evaluation of parameters like propagation constant, attenuation constant, wave velocity, and phase velocity of a wave in different media. **Attitudes:** Analyze and problem-solving

3. Syllabus

ELECTROMAGNETIC WAVES SEMESTER – IV			
Course Code	**M23BEC402**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P:S)	**2:2:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Study the different coordinate systems, Physical significance of Divergence, Curl and Gradient.
- Understand the applications of Gauss law to different charge distributions and the applications of Laplace's and Poisson's Equations to solve real time problems on capacitance of different charge distributions.
- Understand the physical significance of Biot-Savart's, Ampere's Law and Stokes' theorem for different current distributions.
- Infer the effects of magnetic forces, materials and inductance.

- Know the physical interpretation of Maxwell's equations and applications for Plane waves for their behavior in different media.
- Acquire knowledge of Poynting theorem and its application of power flow.

Module -1	
Revision of Vector Calculus (only formulae) – **(Text 1: Chapter 1)** **Electric Field Intensity and Flux density**: Electric field intensity, Field due to continuous volume charge distribution, Electric flux density, Numerical Problems. **Gauss's law and Divergence**: Gauss' law, Application of Gauss' law to point charge, line charge, Surface charge and volume charge, Point (differential) form of Gauss law, Divergence. Maxwell's First equation (Electrostatics), Vector Operator ▼ and divergence theorem, Numerical Problems	L1, L2, L3
Module -2	
Energy, Potential and Conductors: Energy expended or work done in moving a point charge in an electric field, The line integral, Definition of potential difference and potential, The potential field of point charge, Potential gradient, Numerical Problems**.** Current and Current density, Continuity of current. **Poisson's and Laplace's Equations**: Derivation of Poisson's and Laplace's Equations, Uniqueness theorem, Examples of the solution of Laplace's equation, Numerical problems on Laplace equation.	L1, L2, L3
Module -3	
Steady Magnetic Field: Biot-Savart Law, Ampere's circuital law, Curl, Stokes' theorem, Magnetic flux and magnetic flux density, Numerical problems. **Magnetic Forces**: Force on a moving charge, differential current elements, Force between Differential current elements, Numerical problems.	L1, L2, L3
Module -4	
Magnetic Materials: Magnetization and permeability, Magnetic boundary conditions, The magnetic circuit, Numerical problems. **Maxwell's equations:** Faraday' law of Electromagnetic Induction –Integral form and Point form, Numerical problems. Continuity equation, Inconsistency of Ampere's law with continuity equation, displacement current, Conduction current, Derivation of Maxwell's equations in point form, and integral form, Maxwell's equations for different media, Numerical problems.	L1, L2, L3
Module -5	
Uniform Plane Wave: Plane wave, Uniform plane wave, Derivation of plane wave equations from Maxwell's equations, Solution of wave equation for perfect dielectric, Relation between E and H, Wave propagation in free space, Solution of wave equation for sinusoidal excitation, wave propagation in any conducting media (**γ, α, β, η**) and good conductors, Skin effect or Depth of penetration, Poynting's theorem and wave power, Numerical problems.	L1, L2, L3

Text Books:

1. W.H. Hayt and J.A. Buck, ―Engineering Electromagnetics ‖, 8th Edition, Tata McGraw- Hill, 2014, ISBN-978-93-392-0327-6.
2. S P Basavaraju, "Engineering Electromagnetics", Subhas publications, ISBN-13 5551234091737

Reference Books:

1. Elements of Electromagnetics – Matthew N.O., Sadiku, Oxford university press, 4thEdn.
2. Electromagnetic Waves and Radiating systems – E. C. Jordan and K.G. Balman, PHI, 2ndEdn.
3. Electromagnetics- Joseph Edminister, Schaum Outline Series, McGraw Hill.
4. Fundamentals of Electromagnetics for Engineering, Pearson-- N. Narayana Rao

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-3: Vectors, Electric Field Intensity and Flux density, Gauss's law and Divergence	• Vector basics are required for understanding the concepts and solving numerical problems. • Gauss's laws and its application for point, line, and surface charge are discussed. • EFI due to different charge configurations are discussed. • The concept of divergence of a vector is discussed. Numerical on all the concepts are solved.
2.	Week 4-6: Energy, Potential, and Conductors	• Energy expended in moving a charge is discussed which is essential to find potential at a point. • Potential at a point due to different charge configurations are discussed. • Current, current density and displacement current concepts are discussed.

	Poisson's and Laplace's Equations	• Poisson's and Laplace's equations for different capacitors arrangements are discussed. Numerical problems on these concepts are solved.
3.	Week 7-8: Steady Magnetic Field, Magnetic Forces	• Biot-savarts law, Ampere's law, and Stoke's theorem which governs magneto statics are discussed. • Applications of Biot-savarts law and Ampere's law are discussed. • Magnetic force on a charge due to current elements, and long current-carrying conductors are discussed. • Numerical problems on these concepts are solved.
4.	Week 9-10: Magnetic Materials and Maxwell's equations	• Magnetization and permeability concepts are discussed. • Magnetic boundary conditions for interface between dielectric and conductor are discussed. • Maxwell's equations for different media are discussed. • Numerical problems on these concepts are solved.
5.	Week 11-12: Uniform Plane Wave	• Plane wave, Uniform plane wave are discussed. • Derivation of plane wave equations from Maxwell's equations is discussed. • Solution of wave equation for perfect dielectric and Relation between E and H are discussed. • Wave propagation in free space, any conducting media (**γ, α, β, η**)and good conductors is discussed. • Skin effect or Depth of penetration, Poynting's theorem and wave power concepts are discussed. • Numerical problems on these concepts are solved.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to reinforce Competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Field concepts.
3.	Collaborative Learning	Encourage collaborative learning for improved competency application.
4.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of Competencies
5.	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
6.	Assignments	Give more problems to enhance problem solving skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

The average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

1. The question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 questions from each module, each of the two questions under a module (with a maximum of 3 sub-questions), may have a mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1.	Understanding of vector analysis	Study the different coordinate systems, Physical Significance Of Divergence, Curl, and Gradient.
2.	Applying Gauss' law by analyzing different charge configurations	Understand the applications of Gauss' law to different charge distributions and the applications of Laplace's and Poisson's Equations to solve real-time problems on capacitance of different charge distributions.
3.	Applying Biot-savarts law and Ampere's law by analyzing different current distributions	Understand the physical significance of Biot-Savart's, Ampere's Law, and Stokes' theorem for different current distributions.
4.	Understanding magnetic forces and magnetic materials	Infer the effects of magnetic forces and materials
5.	Understanding of Maxwell's equations and uniform plane waves	Know the physical interpretation of Maxwell's equations and applications for Plane waves for their behavior in different media. Acquire knowledge of Poynting's theorem and its application to power flow

8. Course Outcomes (COs) and Mapping with POs/ PSOs Course Outcomes (COs)

	Description
M23BEC402.1	Understand the applications of vectors and vector operators(divergence, gradient, and curl) related to electromagnetic fields
M23BEC402.2	Apply the principles of electrostatics to derive and find the quantities related to electric field, electric flux density, electric potential, boundary conditions, and capacitance arrangements.
M23BEC402.3	Apply the principles of magneto statics to derive and find the quantities related to magnetic Field, magnetic flux density, magnetic forces and boundary conditions.
M23BEC402.4	Understand the concepts related to Faraday's law, induced EMF, and Maxwell's equations.
M23BEC402.5	Apply Maxwell's equations to derive and find the quantities related to electromagnetic waves and uniform plane wave propagation.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC402.1	3	-	-	-	-	-	-	-	-	2	-	-	3	-
M23BEC402.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC402.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC402.4	3	-	-	-	-	-	-	-	-	2	-	-	3	-
M23BEC402.5	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC402	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	5	7				12
Module 2	5	8				13
Module 3	5		5			10
Module 4				5		5
Module 5					10	10
Total	15	15	5	5	10	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	10	10				20
Module 2	10	10				20
Module 3	10		10			20

Module 4				20		20
Module 5					20	20
Total	30	20	10	20	20	**100**

10. Future with this Subject

The "Electromagnetic waves" course in the fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. These applications and significance of electromagnetic wave theory in advanced electronics and communication engineering, enabling the development of diverse technologies that shape our modern world. Here are some notable contributions:

1. Antennas and Propagation: Antennas are essential components in communication systems for transmitting and receiving electromagnetic waves. Understanding electromagnetic wave theory helps engineers design antennas with specific radiation patterns, polarization, and efficiency. This knowledge also aids in predicting and optimizing wave propagation characteristics, enabling the efficient deployment of wireless communication networks.
2. Wireless Communication Systems: Electromagnetic wave theory forms the basis for wireless communication technologies such as cellular networks, Wi-Fi, Bluetooth, and satellite communication systems. Engineers leverage this theory to design modulation schemes, coding techniques, and signal processing algorithms to transmit and receive data reliably over the air.
3. Radar Systems: Radar systems utilize electromagnetic waves to detect and track objects in the atmosphere, on land, or at sea. By analyzing the principles of wave propagation, reflection, and scattering, engineers can design radar systems for applications such as air traffic control, weather monitoring, surveillance, and navigation.
4. Microwave Engineering: Electromagnetic wave theory is instrumental in the design of microwave components and circuits used in high-frequency communication systems, radar systems, and microwave ovens. Engineers use waveguide theory, transmission line theory, and microwave circuit design techniques to develop devices such as amplifiers, filters, mixers, and oscillators for microwave applications.
5. Optical Communication Systems: In optical communication systems, electromagnetic wave theory extends to the domain of light waves. Engineers apply concepts such as fibre optics, waveguides, and photonic devices to design high-speed data transmission systems for telecommunications, internet infrastructure, and data centers.
6. Electromagnetic Compatibility (EMC): EMC is crucial in ensuring that electronic devices operate without interfering with each other or with surrounding equipment. Electromagnetic wave theory helps engineers analyze electromagnetic interference (EMI) and electromagnetic susceptibility (EMS) to design systems with proper shielding, grounding, and filtering techniques.

4th Semester	Professional Course (PC) ANALOG COMMUNICATION SYSTEM	M23BEC403

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Mathematics	Proficiency in algebra, trigonometry, differentiation and integration is crucial, as these concepts are often used in signal processing and system analysis.
2.	Basic circuit theories	Familiarity with components like resistors, capacitors, and inductors, as well as concepts such as Ohm's law, Kirchhoff's laws, and AC/DC analysis.
3.	Knowledge of Electronic components and circuits	Understanding of voltage, current, and their behavior in electronic circuits. Basic knowledge of how analog circuits function, including amplifiers, oscillators.
4	Concepts of communication theory	Familiarity with fundamental concepts such as bandwidth, modulation, demodulation, noise and signal-to-noise ratio (SNR).

2. Competencies

S/L	Competency	KSA Description
1.	Amplitude modulation and demodulation techniques	**Knowledge:** Understanding of characteristics of signals and their principles. **Skills:** Designing and building of AM modulator and demodulators circuits and understanding the components like mixers, oscillators, and amplifiers. **Attitudes:** Significance of AM in communication process, being used for radio broadcasting.
2.	Frequency Modulator and demodulation techniques	**Knowledge:** Understanding of principles of FM Modulators and demodulators Circuits. **Skills:** Designing and building of FM modulator and demodulators circuits in communication systems. **Attitudes:** Significance of FM in communication process, being used for radio broadcasting.
3.	Pulse Modulation and demodulation techniques	**Knowledge:** Understanding of principles of pulse Modulators and demodulators Circuits. **Skills:** Designing and building of pulse modulator, demodulators circuits in communication systems and optimizing the behavior of circuits. **Attitudes:** Valuing the importance of pulse modulation and demodulation in communication process, being used for radio broadcasting.
4.	Random process	**Knowledge:** Understanding the random processes in communication systems for real-world signals and noise. **Skills:** Mastering the skills related to random processes in communication systems is essential for designing, analyzing, and optimizing communication systems. **Attitudes:** Random processes in communication systems require that foster effective problem-solving techniques.
5	Filtering circuits and applications.	**Knowledge:** Understanding the different types of filters circuits used in communication process. **Skills:** Designing and building of different types filters for communication system. **Attitudes:** Valuing the importance of filters in modulators and demodulators in communication process, being used for radio broadcasting.
6	Basic knowledge of Electromagnetic spectrum	**Knowledge:** Understanding the electromagnetic (EM) frequency spectrum for working in fields related to communications, broadcasting. **Skills:** To effectively work with the electromagnetic frequency spectrum, requires a set of theoretical knowledge and practical application **Attitudes:**

		Valuing the importance of Electromagnetic (EM) spectrum analysis in communication process.

3. Syllabus

ANALOG COMMUNICATION SYSTEM SEMESTER – IV			
Course Code	**M23BEC403**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**2:2:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

- Understand and analyze concepts of Analog Modulation schemes viz; AM, FM.
- Understand and analyze concepts of Analog Modulation schemes of pulse modulations.
- Design and analyze the electronic circuits for AM, FM modulation and demodulation.
- Understand and design of filter circuits for AM, FM modulation and demodulation.
- Understand the concepts of random variable and random process to model communication systems in presence of noise.

Module -1	
Amplitude Modulation Fundamentals: AM Concepts, Modulation index and Percentage of Modulation, Sidebands and the frequency domain, AM Power, Single Sideband Modulation. **AM Circuits:** Amplitude Modulators: Diode Modulator, Transistor Modulator, collector Modulator. **Amplitude Demodulators:** Diode Detector, Balanced Modulators: Lattice Modulators**.** **Frequency Division Multiplexing:** Transmitter-Multiplexer, Receiver-Demultiplexer.	L1, L2, L3
Module -2	
Fundamentals of Frequency Modulation: Basic Principles of Frequency Modulation, Principles of Phase Modulation, Modulation index and sidebands, Noise Suppression Effects of FM, Frequency Modulation versus Amplitude Modulation. **FM Circuits:** Frequency Modulators: Voltage Controlled Oscillators. Frequency Demodulators: Slope detectors, Phase Locked Loops.	L1, L2, L3
Module -3	
Pulse modulation: Pulse Amplitude Modulation, Time-Division Multiplexing, Pulse Width Modulation, Pulse Position Modulation: Generation and Detection of PPM wave. **Communication Receiver:** Super heterodyne receiver, Frequency Conversion: Mixing Principles, JFET Mixer.	L1, L2, L3
Module -4	
RANDOM PROCESS: Random Variables and Processes: Introduction, Probability, Conditional Probability, Random Variables. Statistical Averages: Function of a random variable, Moments, Random Processes, Mean, Correlation, and Covariance function: Properties of the autocorrelation function, Cross-correlation functions. **Filters**: First and Second Order Low pass, High Pass. First order Band Pass Filter. Band Rejection Filter.	L1, L2, L3
Module -5	
EM frequency spectrum: Electro Magnetic frequency spectrum, bandwidth and channel capacity and data rate, signal of modern telecommunication system. **Noise:** Signal to Noise Ratio, External Noise, Internal Noise, Semiconductor Noise, Expressing Noise Levels, Noise in Cascade Stages, Figure of Merit of AM, FM.	L1, L2, L3

TEXT BOOKS:

1. Louis E Frenzel, Principles of Electronic Communication Systems, 3rd Edition, Mc Graw Hill Education (India) Private Limited, 2016. ISBN: 978-0-07-066755-6.
2. Simon Haykin & Michael Moher, Communication Systems, 5th Edition, John Wiley, India Pvt. Ltd, 2010, ISBN: 978-81-265-2151-7.

REFERENCE BOOKS:

1. Modern digital and analog Communication systems B. P. Lathi, Oxford University Press., 4th ed.
2. Communication Systems, Harold P.E, Stern Samy and A Mahmond, Pearson Edn.
3. Communication Systems: Singh and Sapre: Analog and digital TMH 2nd Edn.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3	**Amplitude Modulation Fundamentals:** AM Concepts, Modulation index and Percentage of Modulation, Sidebands and the frequency domain, AM Power, Single Sideband Modulation. **AM Circuits:** Amplitude Modulators: Diode Modulator, Transistor Modulator, collector Modulator. Amplitude **Demodulators:** Diode Detector, Balanced Modulators: Lattice Modulators**.** **Frequency Division Multiplexing:** Transmitter-Multiplexer, Receiver-Demultiplexer.
2	Week 4-6:	**Fundamentals of Frequency Modulation:** Basic Principles of Frequency Modulation, Principles of Phase Modulation, Modulation index and sidebands, Noise Suppression Effects of FM, Frequency Modulation versus Amplitude Modulation. **FM Circuits:** Frequency Modulators: Voltage Controlled Oscillators. Frequency Demodulators: Slope detectors, Phase Locked Loops.
3	Week 7-9:	**Pulse modulation:** Pulse Amplitude Modulation, Time-Division Multiplexing, Pulse Width Modulation, Pulse Position Modulation: Generation and Detection of PPM wave. **Communication Receiver:** Super heterodyne receiver, Frequency Conversion: Mixing Principles, JFET Mixer.
4	Week 10-12:	**RANDOM PROCESS:** Random Variables and Processes: Introduction, Probability, Conditional Probability, Random variables. Statistical Averages: Function of a random variable, Moments, Random Processes, Mean, Correlation and Covariance function: Properties of autocorrelation function, Cross–correlation functions. **Filters**: First and Second order Low pass , High Pass. First order Band Pass Filter. Band rejection Filter.
5	Week 13-14:	**EM frequency spectrum**: Electro Magnetic frequency spectrum, bandwidth and channel capacity and data rate, signal of modern telecommunication system. **Noise:** Signal to Noise Ratio, External Noise, Internal Noise, Semiconductor Noise, Expressing Noise Levels, Noise in Cascade Stages, Figure of Merit of AM, FM.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Communication concepts.
3.	Collaborative Learning	Encourage collaborative learning for improved competency application.
4.	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6.	Multiple Representations	Introduce topics in various representations to reinforce competencies
7.	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8.	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies.
9.	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Professional Course (PC) Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.

2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1.	Understanding Analog Fundamentals	Students will grasp the fundamental concepts of signals and systems.
2.	Designing modulators and demodulators Circuits	Students will learn to design and implement modulators and demodulators circuits.
3.	Proficiency in modulation techniques.	Students will become proficient in analyzing modulation and demodulators techniques.
4.	Project-Based Learning	Through hands-on projects, students will apply their knowledge to designing modulators and demodulators Circuits.
5.	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6.	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs course outcomes (COs)

Cos	Description
M23BEC403.1	**Apply** the basics of transistor circuits, signals and systems, electromagnetic spectrum concepts to implement the analog modulation and demodulation techniques in communication systems.
M23BEC403.2	**Apply** the knowledge of communication process to study the parameters communication system.
M23BEC403.3	**Analyse** the analog communication techniques in time and frequency domain.

M23BEC403.4	**Analyze** the performance of analog modulation schemes in presence of noise at the receiver.

Mapping with POs/ PSOs

COs/Pos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
M23BEC403.1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC403.2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC403.3	3	3	-	-	2	-	-	-	-	-	-	-	2	-
M23BEC403.4	3	3	-	-	2	-	-	-	-	-	-	-	2	-
M23BEC403	3	3	-	-	2	-	-	-	-	-	-	-	2	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5				10	10
Total	10	10	10	20	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	05	05	05	05	20
Total	25	25	25	25	**100**

10. Future with this Subject

The "Analog Communication" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of communication systems. Here are some notable contributions.

- **Specialized Applications**: Analog communication remains vital in specific areas where its properties are advantageous of audio and video broadcasting, analog signals can provide high-quality, continuous transmission with minimal latency.
- **Hybrid Systems**: Combining analog and digital technologies can offer the best of both worlds. For example, hybrid systems might use analog signals for their robustness in noisy environments and digital signals for their efficiency and ease of processing.
- **Educational and Historical Value**: The analog communication is valuable for educational purposes and historical understanding. Studying analog systems can provide insights into the evolution of communication technology.
- **Project Work and Research:** The hands-on experience gained through assignments, problem-solving, and project work in analog communication It equips them with the skills needed for research in the field of communication systems.
- **Industry Applications:** The course provides practical skills that are directly applicable in industries related to analog systems and more. Graduates are well-prepared to contribute to industries developing communication hardware and systems.

4th Semester	Integrated Professional Course (IPC) CONTROL SYSTEMS	M23BEC404

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Electricals	• Understanding of voltage, current, and their behavior in electrical circuits. • Proficiency in applying Ohm's Law, Kirchhoff's Current Law, and Kirchhoff's Voltage Law to Electrical Circuits.
2.	Mathematics	• Proficiency in Differential Equations and Laplace Transform to perform mathematical modeling of Physical systems.
3.	Physics	• Understanding of Force, Mass, Friction, Spring, Inertia, Displacement, Velocity, Acceleration, Angular Displacement, Angular Velocity, Angular Acceleration and Newton's laws.
4.	Simulations	• Familiarity in simulation tools such as MATLAB, SCILAB, and OCTAVE to carry out simulations.

2. Competencies

S/L	Competency	KSA Description
1.	Mathematical model for electrical and mechanical Systems.	**Knowledge**: Kirchoff's Voltage Law, Kirchoff's Current Law, D'Alembert's Principles, Laplace transforms Differential equation. **Skills**: Applying KVL, KCL to electrical systems and applying D'Alembert's Principles to mechanical systems to compute transfer function. **Attitudes:** Mathematical aptitude, Problem-solving ability, Analytical Skills, Critical Thinking.
2.	Block diagram Algebra and Mason's Gain Formula.	**Knowledge:** Transfer function, Laplace Transform, Block Diagram Reduction Rules, Signal Flow Graph Terminologies, Mason's Gain Formula. **Skills:** Utilizing the BDR rules to find the transfer function, Applying Mason's gain formula to find the transfer function. **Attitudes:** Problem-solving ability, Analytical Skills, Critical Thinking.
3.	Time response of feedback control system.	**Knowledge:** Standard input signals, Unit step response of First and Second order systems, Time response specifications of second order system, Steady state errors, and constants. **Skills:** Utilizing time response specification to analyze the time response of first and second-order systems, compute steady-state error and constants. **Attitudes:** Problem solving ability, Critical Thinking.
4.	Stability analysis	**Knowledge:** Conditions for Stability, Routh stability Criterion, and Relative stability. Rules and Construction of Root Locus technique, Gain Margin, Phase Margin, Rules and Construction of Bode plot and Nyquist plot. **Skills:** Apply the concept of RH criterion to comment on stability of the system, Utilize the rules of Root Locus to construct the root loci for the given transfer function and comment on stability. Utilize the rules of Bode plot and Nyquist plot to construct the Bode plot, Nyquist plot for the given transfer function and comment on stability. **Attitudes:** Problem solving ability, Analytical Skills, Critical Thinking.

3. Syllabus

CONTROL SYSTEMS SEMESTER – IV			
Course Code	**M23BEC404**	CIE Marks	**50**

Number of Lecture Hours/Week(L: T: P: S)	**3:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory + 10 Lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course objectives: This course will enable students:

- To impart the basics of control systems and design mathematical models using block diagram reduction, SFG, etc.
- To impart the concepts of Time domain and Frequency domain analysis.
- To analyze the stability of a system from the transfer function.

Module -1	
Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems - Electrical Systems, Mechanical Systems, Analogous Systems, numerical problems.	L1, L2, L3
Module -2	
Block diagrams and signal flow graphs: Transfer functions, Block diagram reduction techniques, SISO and MIMO systems, numerical problems, Signal Flow graphs, Mason's gain formula, numerical problems.	L1, L2, L3
Module -3	
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second Order Systems. Time response specifications of second order systems (Delay time, Rise time, Peak time, Peak overshoot, Settling time), steady-state error and error co-efficient (Kp, Kv, Ka), numerical problems.	L1, L2, L3
Module -4	
Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis, numerical problems on Routh stability criterion. **Introduction to Root-Locus Techniques:** The root locus concepts, rules governing the construction of root loci, and numerical problems on root locus techniques.	L1, L2, L3
Module -5	
Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, gain margin & phase margin, Gain Crossover frequency, and Phase Crossover frequency. Mathematical preliminaries, Nyquist Stability criterion, numerical problems (Stability criteria related to polar plots are excluded).	L1, L2, L3

PRACTICAL COMPONENT

Using suitable simulation software (P-Spice/ MATLAB / Python / SCILAB/ OCTAVE / LabVIEW) demonstrate the following :

1.	Implement block diagram reduction technique to obtain transfer function of a control system. i. Blocks in series. ii. Blocks in parallel. iii. Elimination of loop.
2.	Implement block diagram reduction technique to obtain transfer function of a control system. i. Shifting summing point after the block. ii. Shifting summing point before the block.
3.	Implement block diagram reduction technique to obtain transfer function of a control system. i. Shifting take-off point after the block. ii. Shifting take-off point before the block.
4.	Implement Signal flow graph technique to obtain transfer function of a control system.
5.	Implement time response specification of a second order Under damped System, for different damping factors.
6.	Implement frequency response of a second order System.
7.	Implement frequency response of a lead lag compensator.
8.	Analyze the stability of the given system using Routh stability criterion.
9.	a. Simulation of poles and zeros of a transfer function. b. Analyze the stability of the given system using Root locus.
10.	a. Analyze the stability of the given system using Bode plots. b. Analyze the stability of the given system using Nyquist plot

Text Books:

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

Reference Books:

1. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, PearsonEducation,2002.
2. A. Nagoor Kani, Control System Engineering, RBA Publications, Second edition.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-2: Introduction to Control Systems, Effect of Negative feedback systems, Mathematical modeling of Physical systems.	Basic concepts of Control Systems and its types, Effect of negative feedback systems and numerical problems on finding the transfer function of Electrical systems and Mechanical systems(Translation mechanical systems and Rotational mechanical systems).
2.	Week 3-4: Analogous Systems, Block diagram reduction.	Concept of Analogous systems, numerical problems on analogous systems. Block diagram reduction terminologies, Block diagram reduction rules, SISO and MIMO systems and numerical problems on Block diagram reduction.
3.	Week 5-6: Signal Flow graph, Time response of feedback control system.	Signal Flow graph terminologies, Manson's Gain Formula and numerical problems on Signal Flow graph. Standard test signals, Time response specifications, time response of first and second order systems, Steady state error and Error constants.
4.	Week 7-9: Stability Analysis in time domain	Concept of Stability and necessary condition for Stability, Stability analysis using Routh Hurwitz's criterion, numerical problems on RH criterion. Stability analysis using Root Locus, rules to construct Root Locus and numerical problems on Root Locus.
5.	Week 10-12: Frequency domain analysis and Stability.	Stability analysis using Bode Plot, rules to construct Bode Plot, Gain Margin, Phase Margin, Gain crossover frequency and Phase crossover frequency and numerical problems on Bode Plot. Stability analysis using Nyquist Plot, rules to construct Nyquist Plot and numerical problems on Nyquist Plot.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of the concepts of Control System.
3.	Collaborative Learning	Encourage collaborative learning for improved competency application.
4.	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6.	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
7.	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies.
8	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Theory Course with 4 credits: Integrated Professional Core Course (IPC) CIE Split up for Integrated Professional Core Course (IPC)

Components		Number	Weightage	Max. Marks	Min. Marks
Theory (A)	Internal Assessment-Tests (A)	2	**60%**	**15**	**06**
	Assignments/Quiz/Activity (B)	2	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**
Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
Laboratory(B)	Record Writing Continuous	Continuous	**60%**	**15**	**06**
	Test at the end of the semester	1	**40%**	**10**	**04**
	Total Marks		**100%**	**25**	**10**

Final CIE Marks = (A) + (B)

SEE for IPCC

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium of the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- The question paper may include at least one question from the laboratory component.
- Marks scored will be proportionally scaled down to 50marks.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the Fundamentals of Control Systems	Students will comprehend the fundamental concepts of control system, terminologies related to control system, types of control system, effect of negative feedback control system and mathematical modeling of control system.
2	Proficiency in computing System transfer function and state model	Students will learn to compute the system transfer function using Block diagram and Signal flow graph techniques and also to develop the state model of the given system.
3	Proficiency in stability analysis	Students will become proficient in analyzing the stability of a system using time domain and frequency domain approaches.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of control system to design, implement, simulate, and verify complex systems, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with design of a system, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs Course Outcomes (COs)

Cos	Description
M23BEC404.1	Explain the basic concepts of Control Systems, rules of Block diagram reduction and Signal Flow Graph techniques, Time domain specifications and stability analysis.
M23BEC404.2	Apply the knowledge of differential equations, Block diagram reduction and Signal Flow Graph techniques to determine the transfer function of physical systems.
M23BEC404.3	Apply the concepts of signals to determine the time domain response of 1st and 2nd order systems.
M23BEC404.4	Analyze the stability of open loop and closed loop system in time domain using RH criterion and Root Locus and frequency domain using Bode plot and Nyquist Plot.
M23BEC404.5	Analyze Block diagram reduction and Signal flow graph techniques to compute transfer functions, Time response, Frequency response and stability of Control System using simulation tool.
M23BEC404.6	Simulate the experiment individually or in a team and present the corresponding outcomes and process both orally and in writing.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC404.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC404.2	3	3	-	-	3	-	-	-	-	-	-	-	2	-
M23BEC404.3	3	3	-	-	3	-	-	-	-	-	-	-	2	-
M23BEC404.4	3	3	-	-	3	-	-	-	-	-	-	-	2	-
M23BEC404.5	3	3	-	-	3	-	-	-	2	2	-	-	2	-
M23BEC404.6	3	-	-	-	3	-	-	-	2	2	-	-	2	-
M23BEC404	3	3	-	-	3	-	-	-	2	2	-	-	2	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	CO6	**Total**
Module 1	2	5					7
Module 2	2	5			8	7	7
Module 3	2		5				7
Module 4	2			5			7
Module 5	2			5			7
Total	10	13	5	10	8	7	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	CO6	**Total**
Module 1	2	10			10	10	
Module 2	2	20					
Module 3	2		20				
Module 4	2			10			
Module 5	2			10			
Total	10	30	20	20	20		**100**

10. Future with this Subject

The "Control System" course in the fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program.

- **Advanced Control Systems Courses:** This course covers the concepts of time domain and frequency domain stability analysis of the system, State space model etc., The knowledge gained in control systems course, prepares students to tackle challenging control problems in diverse engineering domains, equipping them with the knowledge and skills needed to design sophisticated control systems that meet stringent performance requirements.
- **Embedded Systems:** Understanding the basic concepts of control systems is crucial for students as it includes most of the fields such as Industrial automation, Aerospace and Defense, Consumer electronics, Medicine devices, Robotics, Internet of things, Home automatics and more.
- **Interdisciplinary Applications:** Control systems have interdisciplinary applications, touching areas such as robotics, automation, aerospace, mechatronics, and more. By studying control systems, students gain insights into how engineering principles from different disciplines converge to solve real-world problems, fostering a holistic understanding of engineering.
- **Signal Processing (SP):** Control systems often involve the analysis and manipulation of signals, which aligns with the principles of signal processing. Understanding signal processing concepts such as filtering, modulation, and spectral analysis is beneficial for students pursuing fields like telecommunications, audio engineering, and biomedical engineering.

4th Semester	Professional Course (PC) SIGNALS AND SYSTEMS	23MBEC405

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Basic Mathematics	Familiarity with the course covering differentiation, Integration and basic differential equations, especially when dealing with continuous time signals and systems.
2.	Transform calculus and Numerical methods	Knowledge of Fourier series, Fourier transforms, and Z-transform.

2. Competencies

S/L	Competency	KSA Description
1	Understanding of Signals and Systems	**Knowledge:** Understand the fundamental definitions and classifications of signals and systems, including sampling and signal functions. **Skills:** Ability to classify and operate on signals (e.g., amplitude scaling, time shifting etc). Proficiency in distinguishing between different system types (linear/nonlinear, causal/non-causal etc). **Attitudes:** Appreciate the foundational concepts of signal processing and the importance of precise analysis.
2	Time domain Analysis of LTI System	**Knowledge:** Know how to model LTI systems using impulse response and convolution techniques. **Skills:** Accurately compute and analyze system behavior using convolution sums and integrals. **Attitudes:** Value systematic problem-solving and the role of convolution in understanding system responses.
3	Fourier Analysis of Periodic Signals.	**Knowledge:** Comprehend the principles of Fourier Series and how they apply to periodic signals and system responses **Skills:** Effectively use Fourier Series to represent and analyze periodic signals. **Attitudes:** Develop a critical approach to analyzing systems and signals through Fourier representation.
4	Fourier Analysis of Aperiodic Signals.	**Knowledge:** Understand the application of Fourier Transforms for analyzing aperiodic signals in both continuous and discrete domains **Skills:** Apply Fourier Transforms and sampling theory to analyze and reconstruct aperiodic signals **Attitudes:** Cultivate curiosity and a deep appreciation for frequency-domain analysis techniques.
5	Z-Transform Applications	**Knowledge:** Understanding of Z-transform properties, region of convergence, and its application in LTI system analysis. **Skills:** Ability to apply Z-transforms for analyzing and solving LTI system problems. Competence in performing inversion of Z-transforms. **Attitudes:** Logical approach to transform analysis and system stability evaluation.

3. Syllabus

SIGNALS AND SYSTEMS SEMESTER – IV			
Course Code	**M23BEC405**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**2:2:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Classify the signals and systems based on their properties and understand different operations on signals.
- Understand the mathematical description of continuous and discrete time signals and systems.
- Analyze the signals in time domain using convolution sum.
- Classify the signals into different categories based on their properties.
- Analyze Linear Time Invariant (LTI) systems in time and transform domains. Build basics for understanding of courses such as signal processing, control system and communication.

Module -1	
Introduction and Classification of signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. **Elementary signals/Functions:** exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sync functions. **Operations on signals:** Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. **Systems:** Definition, Classification: linear and nonlinear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	L1, L2, L3
Module -2	
Time domain representation of LTI System: System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral and convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	L1, L2, L3
Module -3	
System interconnection, system properties in terms of impulse response, step response in terms of impulse response. **Fourier Representation of Periodic Signals:** Introduction to CTFS and DTFS, definition, properties (No derivation) and basic problems (inverse Fourier series is excluded).	L1, L2, L3
Module -4	
Fourier Representation of aperiodic Signals: **FT representation of aperiodic CT signals** - FT, definition, FT of standard CT signals, Properties and their significance. **FT representation of aperiodic discrete signals- DTFT**, definition, DTFT of standard discrete signals, Properties and their significance, **Impulse sampling and reconstruction:** Sampling theorem (only statement) and reconstruction of signals.	L1, L2, L3
Module -5	
Z-Transforms: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems.	L1, L2, L3

Text Books:

1. Simon Haykins and Barry Van Veen, “Signals and Systems”, 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4
2. "Signals and Systems",V.Oppenheim, Alan Willsky and A.Hamid Nawab, Pearson education asia/PHI, 2nd edition, 2006. ISBN: 9789332550230, 9332550239

Reference Books:

1. Michael Roberts, “Fundamentals of Signals & Systems”, 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
2. H.P Hsu, R. Ranjan, “Signals and Systems”, Scham‟s outlines, TMH, 2006.
3. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2005.
4. Ganesh Rao and SatishTunga, “Signals and Systems”, Pearson/ Sanguine.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-4: Introduction to signals, Basic Operations on signals	Introduce fundamental concepts of signals and systems, focusing on classification, operations, and examples from communication and control systems. Definitions of signals and systems, Sampling of analog signals, Continuous and discrete time signals, Classification of signals (even/odd, periodic/non-periodic, etc.), Elementary signal functions (exponential, sine, impulse, etc.), Operation son signals (scaling, shifting, etc.)And System classification (linear/nonlinear, causal/non-causal, etc.)
2	Week 5-6: Time domain representation of LTI System	Explore time-domain analysis of LTI systems using impulse response and convolution techniques, including practical computation methods. System modeling and input-output relations, Impulse response definition, Convolution sum and integral, Graphical methods for convolution (unit step to unit step, etc.),Properties of convolution
3	Week 7-8: System Interconnection and Properties	Analyze how systems interconnect and impact each other, and use Fourier Series to represent and analyze periodic signals. System interconnections, System properties through impulse and step responses, Continuous-Time Fourier Series(CTFS), Discrete Time Fourier Series(DTFS),Properties and basic problems
4	Week 9-10: Fourier Representation of Aperiodic Signals	Study the Fourier Transform for analyzing aperiodic signals, understanding its properties, and applying sampling theory for signal reconstruction. Fourier Transform (FT) for aperiodic signals, FT of Continuous-Time (CT) and Discrete-Time (DT) signals Properties and significance of FT, Sampling theorem (statement only) and Signal reconstruction.
5	Week 11-12: Z-Transforms	Learn the Z-transform for analyzing discrete-time signals, including its properties, inversion techniques, and applications in LTI systems. Introduction to Z-transform, Properties of the Z-transform and Region of Convergence (ROC),Inversion of the Z-transform, Z-transform in LTI system analysis

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of signal processing and communication concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of Competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real- world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation

1) CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2) CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

3) The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20 marks. The medium of the question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	**Learning Objectives**	**Description**
1	Understanding signal and system Fundamentals	Students will be able to understand the basics of signals, their operation, systems, and properties.
2	Proficiency in LTI system	Students will learn to analyze impulse response, convolution, stability, and transfer functions for engineering applications
3	Proficiency in LTI system	Students will develop proficient skills for accurate analysis and processing of digital signals.
4	Project-Based Learning	Through hands-on projects, Students will be able to tackle real-world problems by applying theory to design solutions and fostering critical thinking, collaboration, and practical skills in engineering and communication technologies.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.

8. Course Outcomes (COs) and Mapping with POs/ PSOs Course Outcomes (COs)

Cos	**Description**
M23BEC405.1	**Apply** the basics of signals and systems to perform mathematical operations on Continuous and Discrete Time signals.
M23BEC405.2	**Apply** the convolution operator and its properties to characterize the LTI system for Continuous and Discrete signals.
M23BEC405.3	**Apply** the Transformation techniques like Fourier Transform and Z-Transform on signals to obtain system response.
M23BEC405.4	**Analyze** the Characteristics and properties of signal and system in Time domain.

CO-PO-PSO Mapping

COs/P Os	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO12	PSO 1	PSO 2
M23BEC405.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC405.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC405.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC405.4	3	3	-	-	3	-	-	-	-	-	-	-	3	-
M23BEC405	3	3	-	-	3	-	-	-	-	-	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	3	2	3	2	10
Total	**13**	**12**	**13**	**12**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	5	5	5	5	20
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

The "Signals and Systems" course in the fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of signal processing. Here are some notable contributions:

Digital Signal Processing (DSP): Signals and systems concepts form the foundation for understanding DSP algorithms and techniques.

Communication Systems: Knowledge of signals and systems is essential for analyzing and designing communication systems, including modulation, demodulation, and channel coding

Control Systems: Understanding signal processing and system dynamics is crucial for analyzing and designing control systems for various applications

Image Processing: Signals and systems principles are fundamental to image processing techniques such as filtering, compression, and enhancement

Biomedical Engineering: Signal processing techniques are essential for analyzing physiological signals in biomedical applications like medical imaging and biosignal analysis

Project Work and Research:

Signals and systems provide foundational knowledge and analytical tools essential for project work and research across various domains. They enable precise analysis and design of systems, facilitating tasks such as signal processing, control systems, and communications. Mastery of these concepts allows for the development and implementation of efficient algorithms and models. They support interdisciplinary applications, enhancing projects in fields like biomedical engineering, robotics, and telecommunications. Overall, they equip researchers with the skills to tackle complex problems and innovate in technology-driven areas.

4th Semester	Professional Course Laboratory (PCL) ANALOG COMMUNICATION SYSTEM LABORATORY	23MBECL406

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Analog components	• Understanding of active and passive components. • Familiarity with fundamentals of discrete components and colour codes of resistors, capacitors, diode etc. Transistor, operational amplifiers.
2	Electronic Circuits	• Knowledge of basic electronic components and circuits. • Understanding of amplitude, frequency, and their characteristic behaviour in electronic circuits.
3	Basic circuit analysis	• Ability to analyze and design analog circuits.
4	Analog Circuit Analysis	• Ability to analyze and design analog circuits for different configurations, including linear and nonlinear circuit components.
5	Fundamental analog Electronics Knowledge	• Knowledge of basic analog circuits such as voltage amplifier, oscillators, op-amps etc. • Knowledge of positive and negative feedback amplifiers

2. Competencies

S/L	Competency	KSA Description
1	Analog LPF, HPF, BPF, BEF	**Knowledge:** • Understanding of op amp and its configurations helps in designing filters. **Skills:** • Studying filters often involves practical design and implementation exercises, which help to develop skills in circuit design, simulation, prototyping, and testing. **competency:** • Filters play a critical role in experimental research by enhancing data quality, facilitating analysis. However, their application requires careful consideration of trade-offs, transparency, and validation to ensure the integrity and reliability of experimental findings.
2	Analog modulation techniques. AM, DSB-SC PAM, FM	**Knowledge:** Knowledge in both AM, FM, DSBSC and PAM, to develop a solid foundation in analog modulation techniques, which are essential for understanding modern communication systems applications. **Skills:** Practical skills in AM, FM and PAM, students can become proficient in working with these modulation techniques and apply their knowledge in various fields such as telecommunications. **competency:** • Individuals can approach the study and application of AM, FM and PAM with a mindset to understanding, and mastery of these modulation techniques.
3	Pulse amplitude modulations, time division multiplexing TDM, PWM, PPM	**Knowledge:** Knowledge can develop a comprehensive understanding of TDM, PWM, PPM and its role in modern telecommunications and data transmission systems. **Skills:** The skills, can become proficient in designing, implementing, and troubleshooting TDM, PWM, PPM systems, preparing them for careers in telecommunications. **competency:** This approach TDM, PWM, PPM with a mindset conducive to exploration, learning, and success, ultimately contributing to their effectiveness and proficiency in working with systems.
4	IF AMPLIFIER, Phase Locked Loop	**Knowledge:**

		IF amplifiers and PLLs are essential components in communication systems, each playing a distinct role in signal processing and system operation. **Skills:** Skills require a combination of theoretical knowledge, practical experience, and experimentation with real-world circuits. **competency:** The attitudes, you can approach the design, implementation, and optimization of IF amplifiers and PLLs with confidence and effectiveness.

3. Syllabus

ANALOG COMMUNICATION SYSTEM LABORATORY SEMESTER – IV			
Course Code	**M23BECL406**	CIE Marks	**50**
Number of Lecture Hours/Week (L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total No. of Lecture hours	**12 Lab Sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Understand and analyse concepts of Analog Modulation schemes viz; AM, FM.
- Design and analyse the electronic circuits for AM and FM modulation and demodulation process and filters.
- Design and analyse the op amp circuits for different applications.

Sl No	**Experiments**
1	Second order active LPF and HPF.
2	Second order active BPF and BEF.
3	Amplitude modulation using transistor/FET (Generation and detection) .
4	Pulse amplitude modulation and detection
5	Illustration of DSB-SC modulation and demodulation.
6	Design and test Time Division Multiplexing and Demultiplexing of two band limited signals.
7	Design and test PWM.
8	Design and test PPM.
9	Frequency modulation using 8038/2206
10	IF amplifier design.
11	Frequency synthesis using PLL.
12	Design an instrumentation amplifier of a differential mode gain of ‘A’ using three amplifiers.

4. Syllabus Timeline

S/L	**Syllabus Timeline**	**Description**
1	Week 1-2:	Second order active LPF and HPF. Second order active BPF and BE.
2	Week 3-6:	Amplitude modulation using transistor/FET (Generation and detection) . Pulse amplitude modulation and detection Illustration of DSB-SC modulation and demodulation. Design and test Time Division Multiplexing and Demultiplexing of two band limited signals.
4	Week 7-10:	PWM and PPM Frequency modulation using 8038/2206 IF amplifier design. Frequency synthesis using PLL.

5. Teaching-Learning Process Strategies

S/L	**TLP Strategies:**	**Description**
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of communication concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.

4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.

6. **Assessment Details (both CIE and SEE)**

CIE for Practical Courses (Experiment Based): 1 Credit Courses

- CIE marks for a practical course shall be 50 marks.
- The split up of CIE marks for record / journal and test to be split in the ratio 60:40
- Record write up for individual experiment will be evaluated for 10 Marks
- Total marks scored for record writing and conduction shall be scaled downed to 30 marks (60% of maximum marks)
- One test for100 marks after the completion of the experiments at the end of the semester

Test Marks distribution for Experiment-based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	60
2	Viva-Voce	40%	40
Total		**100%**	**100**

The Test marks should be scaled down to 20 marks (40% of the **maximum CIE Lab Marks (50)**)

Final CIE in Practical Course:

Marks distribution for Experiment-based Practical Course for Final CIE

Sl. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal	60%ofthe maximum	30
2	Scaled Down marks of test	40%ofthe maximum	20
Total		**100%**	**50**

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understand the Fundamentals Signals and circuits	Students will grasp the fundamental concepts of signals and communication systems.
2	Project-Based Learning	Through hands-on projects, students will apply their knowledge to designing modulators and demodulators Circuits.
3	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
4	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BECL406.1	Apply the basic concepts of Linear ICs and Communication systems for various modulation and demodulation process.
M23BECL406.2	Design and Implement Filters, amplifiers, modulators and demodulators, mixer, oscillators.
M23BECL406.3	Present the observation in written /oral form either individually/team.
M23BECL406.4	Documentation of the complete Experimental process.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BECL406.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BECL406.2	-	2	3	-	-	-	-	-	3	-	-	-	-	2
M23BECL406.3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BECL406.4	-	2	-	-	-	-	-	-	-	-	-		3	
M23BECL406	3	2	3	-	-	-	-	-	3	3	-	-	3	2

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**10**				**10**
Module 2		**10**			**10**
Module 3			**10**		**10**
Module 4				**10**	**10**
Module 5	**2**	**3**	**2**	**5**	**10**
Total	**12**	**13**	**12**	**15**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**20**				**20**
Module 2		**20**			**20**
Module 3			**20**		**20**
Module 4				**20**	**20**
Module 5	**5**	**5**	**5**	**5**	**20**
Total	**25**	**25**	**25**	**25**	**100**

10. Future with this Subject

For those interested in electronics engineering, there are several avenues to deepen their Analog Communication skills while focusing on relevant topics. Here are some suggestions for future learning:
The "Analog Communication" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of communication systems. Here are some notable contributions:

- Project Work and Research: The hands-on experience gained through assignments, problem-solving, and project work in analog communication It equips them with the skills needed for research in the field of communication systems.

- Industry Applications: The course provides practical skills that are directly applicable in industries related to analog systems and more. Graduates are well-prepared to contribute to industries developing communication hardware and systems.

In summary, the "Analog communication" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

4th Semester	Engineering Science Course (ES) EMBEDDED SYSTEMS	M23BEC407A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electronics and Circuit Design	• Understanding of fundamental electronics concepts, including the behavior and characteristics of electronic components. • Knowledge of basic electronic components and circuits.
2	Microprocessors /Microcontroller systems (Basic)	• Understanding of Microprocessor/Microcontroller operation.
3	Mathematics	• Knowledge of algebra is important for understanding and manipulating • mathematical expressions
4	ComputerNetworks (Basic)	• Familiarity with computer networking concepts, such as protocols and communication models, would be beneficial for understanding communication protocols used in embedded systems.
5	Previous Coursework	• Completion of introductory courses in Basic electronics or a related field

2. Competencies

S/L	Competency	KSA Description
1	Fundamentals of Embedded Systems	**Knowledge:** • Understand the difference between embedded systems and general computing systems. • Recognize various classifications of embedded systems. • Identify major applications and purposes of embedded systems. • Comprehend the fundamental elements of embedded systems. **Skill:** • Analyze and differentiate embedded systems from general computing systems. • Classify embedded systems based on their applications and purposes. • Identify and describe the different components within an embedded system. • Ability to identify and select appropriate sensors and actuators for specific applications **Attitude:** • Demonstrate curiosity and willingness to explore various applications of embedded systems.
2	Embedded System Design Approach	**Knowledge:** • Understand the characteristics and attributes of embedded systems. • Differentiate between operational and non-operational quality attributes. • Comprehend the concepts of hardware-software co-design and program models. • Familiarize with embedded firmware design and development. **Skill:** • Apply hardware-software co-design principles and model programs effectively. • Design and develop embedded firmware. **Attitude:** • Maintain a quality-oriented mindset towards the development of embedded systems.
3	EmbeddedOperating Systems	**Knowledge:** • Understand the basics of operating systems and various types of operating systems. • Learn about tasks, processes, and threads • Comprehend task scheduling techniques, task communication, and synchronization issues. **Skill:** • Apply knowledge of operating systems to manage tasks, processes, and

		threads in embedded systems. • Implement preemptive task scheduling and address task synchronization issues effectively. • Use semaphores to manage resource access and ensure proper synchronization in embedded systems. **Attitude:** • Maintain a meticulous and problem-solving attitude when dealing with operating system concepts.
4	Embedded System Development Environment	**Knowledge:** • Understanding of embedded program development processes. **Skill:** • Develop and debug embedded programs efficiently. **Attitude:** • Maintain an innovative and forward-thinking attitude towards practical implementation of embedded systems.
5	Embedded System Applications	**Knowledge:** • Knowledge of various embedded system applications (automotive, RFID, Robotics, Biomedical, BMI) **Skill:** • Proficiency in knowing working of embedded system in applications **Attitude:** • Develop curiosity and eagerness to explore and understand applications of embedded systems.

3. Syllabus

EMBEDDED SYSTEMS **SEMESTER – IV**			
Course Code	**M23BEC407A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course objectives: This course will enable students to: • Understand the basic hardware components and their selection method based on the characteristics andattributes of an embedded system. • Develop the hardware-software co-design and firmware design approaches. • Explain the need for real-time operating systems for embedded system applications. • Provide an overview of various applications and domains of embedded systems			
Module -1			
Introduction to Embedded Systems: Embedded vs General computing system, Classification ofEmbedded systems, Major applications and purpose of embedded systems, Elements of an Embedded System, Core of the embedded systems, Memory			L1, L2
Module -2			
Embedded System Components: Sensors, Actuators, Buses and Protocols: Defining Buses and Protocols, On-board Buses for Embedded Systems, External Buses (USB, Ethernet), Controller Area Network (CAN), Wireless Communications Protocols. Embedded firmware, and other system components			L1, L2
Module -3			
Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain- specific, Hardware Software Co-Design and Program Modeling (excluding UML), Embedded firmware design and development (excluding C language).			L1, L2,L3
Module -4			
Embedded Operating Systems: Operating System basics, Types of operating systems, Task, process, and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues -Racing and Deadlock, Concept of Binary and counting semaphores (Mutex example without any program).			L1, L2,L3
Module -5			
Embedded System Development Environment: Embedded Program Development,			L1,

Downloading the Hex File to the Non-volatile Memory **Examples of Embedded Systems:** Automotive Electronics, Radio Frequency Identification, Robotics, Bio-Medical Applications, Brain Machine Interfaces	L2,L3

Text Books:

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition.
2. Das, Lyla B. Embedded systems: An integrated approach. Pearson Education India,2012.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to Embedded Systems	Difference between Embedded and General computing systems, Classification of Embedded systems: as per different categories, Major applications list and purpose of embedded systems, Elements of an Embedded System: many elements together form embedded systems. In that core (processor/controller unit) will be explained.
2	Week 3-5: Embedded System Components	Memory: RAM and ROM, Sensors: working principles of different sensors, Actuators: working principle, Defining Buses and Protocols, operation of On-board Buses such as I2C, SPI. Descriptions of external buses like USB, and Ethernet. Operations and features of protocols like CAN, Wi-fi, etc.
3	Week 6-8: Embedded System Design Concepts	Description of attributes that need to be considered for designing embedded systems. Understanding washing machines as application-specific. Explanation of co-design in designing embedded systems and different program modeling. Apply program modeling for various applications.
4	Week 9-10: Embedded Operating Systems	Understanding of Operating System basics, Types of operating systems, Task, processes, and threads, and multitasking. Apply the task scheduling technique to give the number of processors as per different methods. Description of task scheduling issues.
5	Week 11-12: Embedded System Development Environment	Understanding of assemblers, compilers, and the process involved in conversion from source file to hex file.
6	Week 12-14: Examples of Embedded System	Knowing different embedded systems using in different fields like Automotive Electronics, Radio Frequency Identification, Robotics, Bio-Medical Applications, Brain Machine Interfaces

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of embedded system working or protocols or buses.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate a deeper understanding of competencies
9	Student Role-Play Assignments	Assign any embedded components to give seminars associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the frame work of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1. CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2. CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3. The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	10
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	10
Total Marks				50	20

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium ofthe question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Embedded System Fundamentals and Components	Students will grasp the fundamental concepts of embedded systems and different components in typical embedded systems and various options in those components for different applications.
2	Design Concepts	Students will learn different attributes that need to be considered for the design of embedded systems and program modeling for firmware design
3	Operating System	Students will learn the need for operating systems for embedded systems and concepts of OS.
4	Development Environment	Students will learn about IDE and compilators importance
5	Role-Play Learning	Through seminar, students will learn the components of Embedded systems

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

COs	Description
M23BEC407A.1	**Describe** the basic concepts and elements of embedded systems.
M23BEC407A.2	**Describe** the concepts of operating systems for embedded systems.
M23BEC407A.3	**Apply** the modeling techniques and task scheduling to get scheduling solution and modeling embedded system.

M23BEC407A.4	**Apply** the concepts of embedded systems in Automotive Electronics, Radio Frequency Identification, Robotics, Bio-Medical Applications.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC407A.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC407A.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC407A.3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC407A.4	3	3	-	-	-	-	-	-	-	-	-	2	3	3
M23BEC407A	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4			10		10
Module 5				10	10
Total	10	10	20	10	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4			20		20
Module 5				20	20
Total	20	20	20	20	**100**

10. Future with this Subject

The field of embedded systems has a promising future, and this subject will equip students with the necessary knowledge and skills to contribute to its growth and advancement. Here are some potential future prospects associated with the Embedded Systems subject:

- Internet of Things (IoT): Embedded systems are at the heart of the IoT revolution, enabling the interconnection of devices, sensors, and systems. As IoT continues to expand across various domains, such as smart homes, cities, industries, and healthcare, there will be a significant demand for professionals with expertise in designing anddeveloping embedded systems that can seamlessly integrate with IoT ecosystems.
- Wearable Devices and Healthcare: Embedded systems are the driving force behind wearable devices and advanced medical equipment. As the healthcare industry continues to adopt technologies like remote patient monitoring, intelligent prosthetics, and implantable devices, professionals with expertise in embedded systems for biomedical applications will be highly sought after.

  Autonomous Systems: Embedded systems are critical components of autonomous systems, such as self-driving cars, drones, and robots. As these technologies continue to advance, there will be an increasing need for professionals skilled in designing and programming embedded systems that can handle complex decision-making, navigation, and control tasks.

4th Semester	Engineering Science Course (ES) POWER ELECTRONICS	M23BEC407B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Circuit Theory	Understanding basic circuit elements like resistors, capacitors, inductors, and transformers is essential, students should be comfortable with analyzing and designing electrical circuits.
2	Semiconductor Devices	Power electronics heavily relies on semiconductor devices such as diodes, transistors (bipolar junction transistors and MOSFETs), thyristors, and IGBTs, knowledge on how these devices work and their characteristics are essential.
3	Analog Electronics	Knowledge of analog electronic circuits, such as amplifiers, operational Amplifiers, and feedback systems, is important for designing control anddriving circuits in power electronic systems.
4	Control Systems	Power electronics often involves controlling the flow of power from one source to another. Knowledge of control systems and feedbackmechanisms is necessary for designing efficient and stable power electronic systems.

2. Competencies

S/L	Competency	KSA Description
1.	Knowledge of power semiconductor devices	**Knowledge:** Understanding basic circuit elements like resistors, capacitors, inductors,and transformers is essential **Skills:** Ability in analyzing and designing electrical circuits. **Attitudes:** Appreciation for the importance of Understanding basic circuit elementslike resistors, capacitors, inductors, and transformers in circuit designs.
2.	Introduction to Thyristors	**Knowledge:** Understanding how these devices work and their characteristics is crucial. **Skills:** Analyzing the characteristics of different types of thyristors and theirperformance in circuit designs. **Attitudes:** Appreciation for the role of thyristors in power systems.
3.	Introduction to Controlled Rectifiers andAC voltage controllers	**Knowledge:** Understanding controlled rectifiers and AC voltage controlled devicessince they rapidly turned on and off. **Skills:** Designing of controlled rectifiers for half and full cycle conduction andalso AC controllers for turning on and off in AC devices. **Attitudes:** Appreciation for the role of controlled rectifiers and AC voltagecontrollers in power systems.
4.	Introduction to DC-DC Converters	**Knowledge:** Power electronics deals with switching circuits, where devices are rapidlyturned on and off. Understanding switch-mode operation, duty cycles, and switching losses is essential. **Skills:** Designing of choppers for controlled applications **Attitudes:** Appreciation for the role of DC-DC Converters in power systems.

5.	Introduction to Pulse Width Modulated Inverters and static switches	**Knowledge:** Understanding switch-mode operation, duty cycles, and switching losses is essential. **Skills:** Designing of Pulse Width Modulated Inverters and static switches choppersfor controlled applications **Attitudes:** Appreciation for the role of Pulse Width Modulated Inverters in powersystems.

3. Syllabus

POWER ELECTRONICS SEMESTER – IV			
Course Code	**M23BEC407B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- 1. To understand static characteristics of semiconductor devices to discuss their performance.
- To understand the Triggering of SCR by different methods
- To study and verify the performance of single phase controlled full wave rectifier and ACvoltage controller with R and RL loads.
- To study the Controlling of speed of a DC motor, universal motor and stepper motors.
- To understand the performance of single phase full bridge inverter connected to resistiveload.

Module -1	
Introduction - Applications of Power Electronics, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits, Peripheral Effects. Power Transistors: Power BJTs: Steady state characteristics. Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics, di/dt and dv/dt limitations.	L1,L2
Module -2	
Thyristors - Introduction, Principle of Operation of SCR, Static Anode-Cathode Characteristics of SCR, Two transistor model of SCR, Gate Characteristics of SCR, Turn-ON Methods, Turn-OFF Mechanism, Turn-OFF Methods: Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit, UJT Firing Circuit.	L1, L2,L3
Module -3	
Controlled Rectifiers - Introduction, Principle of Phase-Controlled Converter Operation, and Single-Phase Full Converter with RL Load, Single-Phase Dual Converters, and Single-Phase Semi Converter withRL load. **AC Voltage Controllers -** Introduction, Principles of ON-OFF Control, Principle of Phase Control, Single phase controllers with resistive and inductive loads.	L1, L2,L3
Module -4	
DC-DC Converters - Introduction, principle of step-down operation and it's analysis with RL load, principle of step-up operation, Step-up converter with a resistive load, Performance parameters, Converter classification, Switching mode regulators: Buck regulator, Boost regulator, Buck-Boost Regulators, Chopper circuit design.	L1, L2,
Module -5	
Pulse Width Modulated Inverters- Introduction, principle of operation, performance parameters, Single phase bridge inverters, voltage control of single phase inverters, current source inverters, Variable DC-link inverter, Boost inverter, Inverter circuit design. **Static Switches:** Introduction, Single phase AC switches, DC Switches, Solid state relays, Microelectronic relays.	L1, L2,

Text Books:

1. Mohammad H Rashid, Power Electronics, Circuits, Devices and Applications, 3rd/4th Edition, PearsonEducation Inc, 2014, ISBN: 978-93-325-1844-5.
2. M.D Singh and K B Khanchandani, Power Electronics, 2nd Edition, Tata Mc-Graw Hill, 2009, ISBN:0070583897

Reference Books:

L. Umanand, Power Electronics, Essentials and Applications, John Wiley India Pvt. Ltd, 2009.

Dr. P. S. Bimbhra, ―Power Electronics‖, Khanna Publishers, Delhi, 2012.

P.C. Sen, ―Modern Power Electronics‖, S Chand & Co New Delhi, 2005.

Earl Gose, Richard Johnsonbaugh, Steve Jost, Pattern Recognition and Image Analysis, ePub eBook.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1: Introduction	**Competency**: Power semiconductor devices. **Knowledge**: Working of semiconductor diode and its V-I characteristics. **Skills**: To identify different power semiconductor devices for industrial applications.
2	Week 2: Thyristors	**Competency**: Classification of Thyristor family. **Knowledge**: Working, of SCR, IGBT, GTO, MCT, DIAC and TRIAC. **Skills:** Implementing thyristors in Single phase half wave and full wavecontrolled rectifiers using SCR, UJT & phase shift circuits.
3	Week 3: Controlled Rectifiers andAC voltage controllers	**Competency:** Controlled Rectifiers and AC voltage controllers. **Knowledge**: working of three phase half wave, full wave or bridge rectifier and six phases half wave rectifier and also Operating principle of cyclo - converter. **Skills**: Designing of different configurations of rectifiers and voltage Controllers.
4	Week 4: DC-DC Converters	**Competency:** Types of chopper circuits **Knowledge:** working principle of Chopper **Skills:** Analyzing the working principle of Chopper and its applications.
5	Week 5: Pulse Width Modulated Inverters and static switches	**Competency:** Inverters **Knowledge**: Series and parallel inverter using SCR, PWM method and PWM inverter. **Skills**: Analyzing the working principle of inverters and PWM techniques in controlling the speed of the dc motor.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance Understanding of Power electronics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to eachcompetency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies

9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)	**2**	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	**2**	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations:

1. Question paper pattern will be ten questions. Each question is set for 20marks. The medium ofthe question paper shall be English unless otherwise it is mentioned.
2. There shall be 2 question from each module, each of the two questions under a module (with amaximum of 3 sub questions), may have mix of topics under that module if necessary.
3. The students have to answer 5 full questions selecting one full question from each module.
4. Marks scored will be proportionally scaled down to 50 marks.

7. Learning Objectives

S/L	**Learning Objectives**	**Description**
1	Understanding Power Electronics Fundamentals and its applications.	Students will grasp the fundamental concepts of Power semiconductor devices, working principle of different types conversion techniques andits applications.
2	Designing different types ofcircuits like choppers, AC voltage controllers, Inverters rectifiers.	Students will learn to design and implement different types of circuits like choppers, AC voltage controllers, Inverters rectifiers.
3	Proficiency in designing of Circuits.	Students will become proficient in design and implement different typesof AC and DC circuits
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge ofPower electronics to design, implement, simple and complex circuits, reinforcing their understanding of theoretical concepts
5	Collaboration and CommunicationSkills	Students will work collaboratively in teams on design projects, Enhancing their ability to communicate effectively, share ideas, andsolve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual propertyrights, ensuring design reliability and security, and adhering to industry Standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

CO's	DESCRIPTION OF THE OUTCOMES
M23BEC407B.1	**Understand** the power electronic devices, concepts and their impact upon the power network for control and conversion of electricpower.
M23BEC407B.2	**Apply** the concepts of power semiconductor devices in controlled rectifier, DC-chopper, AC voltage controller and inverters circuits.
M23BEC407B.3	**Analyze** V-I characteristics of power electronic devices such as Thyristor, power BJT, power MOSFET, IGBT.
M23BEC407B.4	Analyze the behavior of circuit elements in power converters and motors.

CO-PO-PSO Mapping

CO No	PO No												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
M23BEC407B.1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC407B.2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC407B.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC407B.4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC407B	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	2	3	2	3	10
Total	12	13	12	13	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	5	5	5	5	20
Total	25	25	25	25	**100**

Conditions for SEE Paper Setting:

Each module of SEE question paper should be allocated with questions for 20% of the total SEEmarks.

10. Future with this Subject

The "Power Electronics" course in the fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of electronics. Here are some notable contributions:

a. Control Systems: Control Systems in Power Electronics focus on designing algorithms andcontrol strategies to regulate power converters. They play a crucial role in ensuring the stability and efficiency of power systems, contributing to advancements in renewable energy and electric vehicle technologies.

b. The convergence of Power Electronics with Internet of Things (IoT) and Artificial Intelligence (AI): The convergence of Power Electronics with Internet of Things (IoT) and Artificial Intelligence (AI) promises unprecedented efficiency and control, redefining how energy is generated, distributed, and consumed. The proliferation of wide-bandgap semiconductors and advanced materials further accelerates the pace of innovation, enabling smaller, more efficient devices.

Power Electronics, in the future, is not merely a component but an integral force shapingsustainable energy solutions. As we navigate this dynamic evolution, the adaptability and foresight within Power Electronics underscore its pivotal role in shaping a more energy-efficient and technologically advanced future. The synergy of these emerging technologies positions Power Electronics at the forefront of the technological

revolution, ensuring a future that is not only connected but also environmentally sustainable.

c. Automotive Electronics: The automotive industry is undergoing a significant transformation with the rise of electric vehicles (EVs). Power Electronics is at the forefront of this revolution, powering EVs with efficient motor drives and energy storage systems. Professionals in this field will find abundant opportunities as the demand for electric transportation continues to grow.

d. Advanced Courses: One of the key advantages of a career in Power Electronics is its versatility.Professionals in this field can seamlessly transition between industries, working on diverse projects ranging from developing power-efficient consumer electronics to designing advanced power systems for space exploration.

e. Project Work and Research: a career in Power Electronics presents a world of opportunitiesfor individuals passionate about shaping the future of technology. From designing efficient power systems to contributing to the renewable energy revolution, Power Electronics professionals are at the forefront of innovation. The field's global demand, versatility, andcontinuous learning opportunities make it an exciting and rewarding choice for those aspiring to make a meaningful impact in the realm of electronic power. As we look towards the future, Power Electronics will undoubtedly continue to play a vital role in shaping a more connected, sustainable, and electrifying world.

f. Industry Applications: The course provides practical skills that are directly applicable inindustries related to controlling equipment, AI and IoT, and more. Graduates are well-prepared to contribute to industries developing Electronics engineers.

In summary, the "Power Electronics" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

4th Semester	Engineering Science Course (ES) COMPUTER ORGANIZATION & ARCHITECTURE	M23BEC407C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electronics and Digital Logic	Understanding of electronic components, basic circuits, and fundamental digital logic concepts, including knowledge of logic gates (AND, OR, NOT) and Boolean algebra.
2	Computer Hardware Fundamentals	Familiarity with basic computer hardware components such as the CPU, memory, and input/output devices.
3	Mathematics and Boolean Algebra	Basic knowledge in algebra, particularly in Boolean expression simplification using Karnaugh maps (K-map) and logic simplification techniques.
4	Binary Number System and Arithmetic	Knowledge of the binary number system and its application in performing basic arithmetic operations.
5	Programming Fundamentals	Basic understanding of programming concepts and skills in assembly language programming or a similar low-level programming language.

2. Competencies

S/L	Competency	KSA Description
1	Assembly Language Programming Knowledge	**Knowledge:** Knowledge of basic instruction sets and their formats. Comprehension of how assembly language maps to machine code.Understanding of stack operations, subroutines, and interrupts. **Skills:** Proficiency in writing, debugging, and optimizing assemblylanguage programs. **Attitudes:** Valuing the insights gained from programming at the hardwarelevel.
2	Computer Architecture	**Knowledge:** Knowledge of the basic components of a CPU (ALU, Registers, control unit). Comprehension of the fetch-decode-execute cycle. **Skills:** Ability to design and analyze simple CPU architectures. Proficiency in understanding and implementing pipelining techniques. **Attitudes:** Interest in optimizing processor performance and efficiency.
3	Memory Systems	**Knowledge:** Knowledge of different types of memory (RAM, ROM,cache, virtual memory). **Skills:** Ability to analyze and optimize memory access patterns **Attitudes:** Appreciation for Efficient Memory Design
4	Input/Output Systems	**Knowledge:** Knowledge of how computers interact with peripheraldevices. **Skills:** Ability to design and analyze I/O systems for various applications. **Attitudes:** Recognition of the importance of efficient I/O design in overall system performance
5	Performance Analysis and Optimization	**Knowledge:** Knowledge of metrics for evaluating computer performance(clock speed, MIPS, FLOPS). **Skills:** Ability to measure and analyze computer performance. **Attitudes:** Recognition of the importance of performance in computersystem design.

3. Syllabus

COMPUTER ORGANIZATION & ARCHITECTURE SEMESTER – IV			
Course Code	**M23BEC407C**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Explain the basic organization of a computer system.
- Explain different ways of accessing an input / output device including interrupts.
- Illustrate the organization of different types of semiconductor and other secondary storagememories.
- Illustrate simple processor organization based on hardwired control and micro programmed control.

Module -1	
Basic Structure of Computers and Instruction Set Architecture: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance – Processor Clock, Basic Performance Equation Numbers, Arithmetic Operations and Characters, IEEE standard for Floating point Numbers,Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing	L1, L2,L3
Module -2	
Fundamentals of Assembly Language and System Architecture: Assembly Language, Basic Input and Output Operations, Stacks and Queues, Subroutines, Additional Instructions.	L1, L2,L3
Module -3	
Input/output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Direct Memory Access.	L1, L2,L3
Module -4	
Memory System: Basic Concepts, Semiconductor RAM Memories-Internal organization of memory chips, Static memories, Asynchronous DRAMS, Read Only Memories, Cash Memories, Virtual Memories, Secondary Storage-Magnetic Hard Disks.	L1, L2,L3
Module -5	
Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hardwired Control, and Microprogrammed Control.	L1, L2,L3
Text Books: 1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer Organization, 5th Edition, Tata McGraw Hill, 2002. 2. David A. Patterson, John L. Hennessy: Computer Organization and Design – TheHardware / Software Interface ARM Edition, 4th Edition, Elsevier, 2009. Reference Books: 1. William Stallings: Computer Organization & Architecture, 7th Edition, PHI, 2006. 2. Vincent P. Heuring & Harry F. Jordan: Computer Systems Design and Architecture, 2nd Edition, Pearson Education, 2004.	

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Basic Structure of Computers and Instruction Set Architecture:	Writing assembly code and understanding system-level hardware-software interactions. Understanding the core components and functionalities ofcomputer systems and their instruction sets
2	Week 3-4: Fundamentalsof Assembly Language and System Architecture	Managing, and optimizing memory hierarchies and architectures understanding assembly language programming andcomprehension of system architecture principles.
3	Week 5-6: "Memory Systems: Concepts and Architectures	Developing and implementing efficient arithmetic and computational algorithms.
4	Week 7-8: Arithmetic Operations and Computation Techniques	Understanding of various arithmetic operations and advanced computation techniques for both integer and floating-point numbers
5	Week 9-10:Basic Processing Unit:	Designing, analyzing, and optimizing basic processing units. Understanding the fundamental components and functions of abasic processing unit. Ability to design, analyze, and optimize the operation of a basic processing unit.
6	Week 11-12:Integration and Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice with programming assignments

5. Teaching learning process strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lectureformat to reinforce competencies.
2.	Collaborative Learning	Encourage collaborative learning for improvedcompetency application.
3.	Higher Order Thinking(HOTS) Questions:	Pose HOTS questions to stimulate critical thinkingrelated to each competency.
4.	Problem-Based Learning(PBL)	Implement PBL to enhance analytical skills andpractical application of competencies
5.	Multiple Representations	Introduce topics in various representations to reinforce competencies
6.	Real-World Application	Discuss practical applications to connect theoreticalconcepts with real-world competencies.
7.	Flipped Class Technique	Utilize a flipped class approach, providing materialsbefore class to facilitate deeper understanding of competencies
8.	Programming Assignments	Assign programming tasks to reinforce practical skillsassociated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

- CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
- CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		Number	Weightage	Max. Marks	Min. Marks
(i)	Internal Assessment-Tests (A)	2	50%	25	**10**
(ii)	Assignments/Quiz/Activity (B)	2	50%	25	**10**
Total Marks				**50**	**20**

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

- Question paper pattern will be ten questions. Each question is set for 20 marks. The mediumof the question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Computer Components	Students should be able to identify and explain the function of essential hardware components such as processors (CPU), memory (RAM), Input /output devices (I/O), and storage (HDD/SSD).

2	ArchitecturePrinciples:	Gain insights into the design principles underlying computer architecture, including instruction set architecture (ISA), data path and control unit Design, pipelining, and memory hierarchy.
3	Proficiency in Memory and I/O Systems	Explore how input and output devices are managed and interfaced withthe CPU, including concepts like interrupts, DMA (Direct Memory Access), and I/O controllers.
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of digital design and, simulate, and verify complex digital systems, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry Standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

COs	Description
M23BEC407C.1	Apply the knowledge of basic concepts of computers, secondary storage devices and its functional units to access the computer in efficient manner.
M23BEC407C.2	Apply machine instruction to access Input/output devices including interrupts using various addressing modes.
M23BEC407C.3	Analyze the different types of semiconductor memories to study internal organization of memory chips and secondary storage memories.
M23BEC407C.4	Analyze the performance of processor, different controlling techniques for basic processing units.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC407C.1	2	-	-	-	-	-	-	-	2	-	-	1	2	-
M23BEC407C.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
M23BEC407C.3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC407C.4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
M23BEC407C	2	2	-	-	-	-	-	-	2	-	-	1	2	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	10				10
Module 2		10			10
Module 3			10		10
Module 4				10	10
Module 5	2	3	2	3	10
Total	12	13	12	13	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5	5	5	5	5	20
Total	25	25	25	25	**100**

10. Future with this Subject

- Next-Generation CPUs and GPUs: Understanding current architecture will provide a foundation to grasp future advancements in processing units, such as quantum processors, AI- specialized chips, and neuromorphic computing.
- Performance Optimization: Knowledge in this field will be crucial for developing methods to optimize performance, energy efficiency, and thermal management in next-generation processors. Advanced

Programming Courses

- Custom Processor Design: With the proliferation of the Internet of Things (IoT), there is a growing need for custom, low-power processors tailored for specific applications, such as smart devices, sensors, and wearable.
- System Integration: Skills in computer organization are essential for integrating various hardware components into a cohesive system, which is a critical aspect of embedded systems design.

4th Semester	Engineering Science Course (ES) APPLICATION OF NUMERICAL METHODS	M23BEC407D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	Proficiency in linear algebra and differential calculus
2	ProgrammingConcepts	Basic understanding of programming concepts
3	Previous Coursework	Fundamental mathematics for engineers, Numerical methods

2. Competencies

S/L	Competency	KSA Description
1	Forming andsolving linear systems of equations	**Knowledge**: Understanding Linear Algebra principles **Skills**: Ability to use algebra, matrix operations **Attitudes**: Appreciation for the importance of linear algebra insolving linear equations
2	Interpolation and Approximation	**Knowledge**: Understanding of interpolation and extrapolation **Skills**: Ability to carry out Interpolation and approximation techniques using different methods **Attitudes**: Appreciation for the importance of interpolation and Extrapolation
3	Numerical Differentiation and Integration	**Knowledge**: Understanding of numerical differentiation andintegration **Skills**: Ability to carry out derivatives using interpolationpolynomials, Simpson's rule, Romberg's method **Attitudes**: Appreciation for the importance of NumericalDifferentiation and Integration
4	Solving Initial Value Problems for Ordinary Differential Equations	**Knowledge**: Understanding of various methods of solving forordinary differential equations **Skills**: Ability to solve initial value problems using various methodsof solving for ordinary differential equations **Attitudes**: Appreciation for the importance of solving Initial ValueProblems for Ordinary Differential Equations
5	Solving Boundary Value Problems in Ordinary and Partial Differential Equations	**Knowledge**: Understanding of various finite difference methods, **Skills**: Ability to solve boundary value problems in ordinary andpartial differential equations **Attitudes**: Appreciation for the importance Boundary ValueProblems in Ordinary and Partial Differential Equations in engineering

3. Syllabus

APPLICATION OF NUMERICAL METHODS SEMESTER – IV			
Course Code	**M23BEC407D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**3:0:0:0**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:

- Understand linear system of equations
- Apply Interpolation and Approximation
- Proficiently apply Numerical Differentiation and Integration

Module -1	
Solution of Equations and Eigen value Problems: Solution of algebraic and transcendental equations, Fixed point iteration method, Solution of linear system of equations, LU -Decomposition Method – Iterative methods of Gauss Jacobi – Matrix Inversion by Gauss Jordan method. Example computer programs.	L1, L2, L3
Module -2	
Interpolation and Approximation: Interpolation with unequal interval: Stirling's formula, Bessel's interpolation formula Interpolation with unequal intervals – Hermite's interpolation formula, Spline interpolation, Cubic Spline interpolation for equally and unequally spaced values	L1, L2, L3
Module -3	
Numerical Differentiation and Integration: Approximation of derivatives using interpolation polynomials - Numerical integration using	L1, L2,

Trapezoidal, Simpson's 1/3 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules	L3
Module -4	
Initial Value Problems: Solution of First order differential equations by Picards method and dams	L1,
Bash forth method. Solution of Second order differential equations by Fourth order Runge-Kutta and Milne's method	L2, L3
Module -5	
Boundary Value Problems in Ordinary and Partial Differential Equations:	
Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.	L1, L2, L3

Text Books:

1. Grewal. B.S. and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9thEdition, New Delhi
2. A.K. Jaiswal and Anju Khandelwal, "A textbook of Computer based numerical and statistical techniques",New Age International, 2009

Reference Books:

1. Chapra. S.C. and Canale. R. P., "Numerical Methods for Engineers, Tata McGraw Hill, New Delhi.
2. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi.
3. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private, NewDelhi.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1 to 3.5: Forming and solving linear system of equations	Forming and solving linear system of equations understanding linear algebra principles, ability to use algebra, and matrix operations, appreciation for the importance of linear algebra in solving linear equations
2	Week 3.5 to 6: Interpolationand Approximation	Use of Interpolation and Approximation, understanding of interpolation and extrapolation, ability to carry out Interpolation and approximation techniques using different methods.
3	Week 6 to 7.5 Numerical Differentiation and Integration	Numerical Differentiation and Integration, understanding of numerical differentiation and integration, carrying out derivatives using interpolation polynomials, Simpson's rule, Romberg's method
4	Week 7.5 to 10 Solving Initial Value Problems for Ordinary Differential Equations	Solve Initial Value Problems for Ordinary Differential Equations Understand various methods of solving for ordinary differential equations, solve initial value problems using various methods of solving for ordinary differential equations
5	Week 10 to 12.5 Solving Boundary Value Problems in Ordinary andPartial Differential Equations	Application of Boundary Value Problems in Ordinary and Partial Differential Equations, solve boundary value problemsin ordinary and partial differential equations

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Collaborative Learning	Encourage collaborative learning for improved competency application.
3	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
4	Multiple Representations	Introduce topics in various representations to reinforce competencies
5	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE) Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendarof events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

- CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
- CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

Continuous Internal Evaluation (CIE)

The minimum CIE marks requirement is 40% of maximum marks in each component.

CIE Split up for Professional Course (PC)

Components		**Number**	**Weightage**	**Max. Marks**	**Min. Marks**
(i)	Internal Assessment-Tests (A)		50%	25	10
(ii)	Assignments/Quiz/Activity (B)		50%	25	10
Total Marks				50	20

Final CIE Marks = (A) + (B)

Average internal assessment shall be the average of the best two test marks from the 2 tests conducted.

Semester End Examinations

- Question paper pattern will be ten questions. Each question is set for 20marks. The medium ofthe question paper shall be English unless otherwise it is mentioned.
- There shall be 2 question from each module, each of the two questions under a module (with a maximum of 3 sub questions), may have mix of topics under that module if necessary.
- The students have to answer 5 full questions selecting one full question from each module.
- Marks scored will be proportionally scaled down to 50 marks

7. Learning Objectives

S/L	**Learning Objectives**	**Description**
1	Understanding linear system of equations	Students will grasp the fundamental concepts of linear system of Equations and methods to solve them.
2	Applying Interpolation and Approximation	Students will learn to apply interpolation and approximation techniques to solve system of equations
3	Proficiency in Numerical Differentiation and Integration	Students will become proficient in solving equations throughnumerical differentiation and integration
4	Program-Based Learning	Through programming assignments, students will apply their knowledge of numerical methods to solve using computertechniques

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

Cos	**Description**
Solve linear system of equations	Perceive and Apply the power of linear system of equations, ideas and be able to demonstrate the applications of these techniques to problems
Apply Interpolation and Extrapolation to solve numerical problems	Applying Interpolation and Extrapolation to solve numerical problemsdata analysis and interpretation can be done for industrial examples
Apply Numerical and Differentiation techniques to solve complex problems	Apply Numerical and Differentiation techniques to solve complex problems data analysis and interpretation can be done for industrial examples
Solve initial value problem and boundary value problem	Solving Initial Value Problems for Ordinary Differential Equations and Solving Boundary Value Problems in Ordinary and Partial Differential Equations

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC407D.1	3	2	1	-	-	-	-	-	-	-	-	-	2	1
M23BEC407D.2	3	2	1	-	-	-	-	-	-	-	-	-	2	1
M23BEC407D.3	3	2	1	-	-	-	-	-	-	-	-	-	2	1
M23BEC407D.4	3	2	1	-	-	-	-	-	-	-	-	-	2	1
M23BEC407D	3	2	1	-	-	-	-	-	-	-	-	-	2	1

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	14				14
Module 2		12			12
Module 3			10		10
Module 4				8	8
Module 5				6	6
Total	14	12	10	14	50

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	20				20
Module 2		20			20
Module 3			20		20
Module 4				20	20
Module 5				20	20
Total	20	20	20	40	100

10. Future with this subject

Growing Demand across Industries:

Numerical methods are the backbone of scientific computing and simulations. As various industries rely more on data analysis, modeling, and complex problem-solving, the demand for professionals skilled in numerical methods will surge.

Fields like engineering, finance, healthcare, and even entertainment utilize numerical methods for tasks like designing structures, analyzing financial markets, simulating drug interactions, and creating computer graphics.

Advancements in Computing Power:

The ever-increasing power and affordability of computing resources will allow for more complex and sophisticated numerical methods to be developed and applied. This opens doors for solving previously intractable problems in various fields.

Interdisciplinary Applications:

Numerical methods are becoming increasingly interdisciplinary. Combining them with other fields like machine learning, artificial intelligence, and data science will lead to powerful new tools for tackling real-world challenges.

Rise of Big Data:

The explosion of data generation across various sectors necessitates efficient tools for data analysis and extraction of knowledge. Numerical methods play a crucial role in handling large datasets and extracting meaningful insights.

4th Semester	Ability Enhancement Course (AE-IV) SIMULINK	M23BEC408A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Understanding of Programming	Fundamental concepts of programming, including syntax, commands, and functions.
2	Understanding of SignalProcessing	Basic signal processing concepts, including sampling, filtering, modulation, and demodulation.
3	Foundational Knowledgein Control Systems	Basic principles of control systems, including feedbackloops, transfer functions, and system stability. Understanding of how control systems are represented andsimulated in Simulink
4	Basic Knowledge of Mathematics and Physics	Understanding of differential equations, linear algebra, andcalculus as they apply to dynamic systems.
5	Basic Communication concepts	Understanding the basics of communication consists of transmitter and receiver section.

2. Competencies

S/L	Competency	KSA Description
1	Full wave rectifier and AC Voltage Controller	**Knowledge: u**nderstanding of how diodes work, especially in the context of rectification. of AC voltage control, including the role of power electronics devices like thyristors, TRIACs, and SCRs **Skills:** Ability to design a full-wave rectifier circuit based on given specifications. AC voltage controller circuits using components like TRIACs and diodes. **Attitudes:** Control parameters to achieve the desired voltage output.
2	AM DSB-AM SSB	**Knowledge:** Understanding of modulation index, sidebands, and spectral characteristics of DSB-SC signals and AM SSB **Skills**: Utilizing Matlab functions for signal processing and analysisAttitude: Simulation parameters and analyzing the role for accuracy **Attitudes:** Simulation parameters to achieve the accuracy
3	Frequency division multiplexingand time division multiplexing	**Knowledge**: The principles of TDM, including time slots, frame Structure and synchronization. Applications and advantages of TDM in communications systems **Skills**: Matlab commands to manipulate data and control Simulinkmodels. **Attitudes**: accuracy in model configuration, parameter settings
4	Frequency Modulation	**Knowledge**: principles of AM, including carrier signal, sidebands, and modulation index, FM, including carrier frequency, modulation index, and frequency deviation. **Skills**: Matlab commands to manipulate data and control Simulinkmodels. **Attitudes**: simulation parameters and analyzing results to ensureaccuracy
5	PWM and PPM	**Knowledge**: principles of PWM, including duty cycle, pulse width, and frequency. **Skills**: Writing scripts and functions in Matlab for signal generation,processing, and analysis. **Attitudes**: ensuring accuracy in script configuration, parameter settings, and interpretation of simulation results.

3. Syllabus

SIMULINK SEMESTER – IV			
Course Code	**M23BEC408A**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total number of Lab sessions	**12**	Total marks	**100**
Credits	**1**	Exam Hours	**3**

Course objectives:
1. Understand the basic signal generation in Matlab Simulink.
2. To perform analysis in frequency and time domain.

Sl. No	Experiments Conduct the following experiments in Matlab Simulink
1.	Simulate single phase full wave rectifier using RLE loads.

2.	Simulate single phase AC voltage controller using RLE Loads.
3.	Simulate resonant pulse commutation circuit.
4.	Simulate of Buck Chopper.
5.	To perform the AM DSB-SC signal generation and detection.
6.	To perform the AM SSB-SC signal generation and detection.
7.	To perform the frequency modulation signal generation and detection.
8.	To perform the operation of FM demodulation with PLL.
9.	To verify the spectral components of AM and FM.
10.	To perform pulse amplitude modulation and demodulation.
11.	To perform the Time division multiplexing.
12.	To perform PWM modulation and demodulation.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	**Week 1:** To simulate single phase full wave rectifier using RLE Loads	To understand and analyze the operation of a single-phase full-wave rectifier circuit using RLE (Resistive-Inductive-Electromotive force) loads, Definition and modeling of RLE loads, including the interaction between resistive (R), inductive (L), and electromotive force (E) components
2	**Week 2:** To Simulate single phase AC voltage controller using RLE Loads	To understand the operation and control of a single-phase AC voltage controller simulate and analyze the performance of the AC voltage controller when connected to RLE
3	**Week3:** To Simulate of resonant pulse commutation circuit.	To understand the principles and operation of resonant pulse commutation in power electronics. Resonant pulse commutation circuit and analyze its performance under various conditions.
4	**Week 4:** To Simulate of Buck Chopper	To understand the working principle and operation of a buck chopper. o simulate a buck chopper circuit and analyze its performance under different load and control conditions.
5	**Week 5**: To perform the AM DSB-SC signal generation and detection using Matlab Simulink	To understand the principles of Amplitude Modulation (AM) with a focus on Double Sideband-Suppressed Carrier (DSB-SC) modulation.
6	**Week 6:** To perform the AM SSB-SC signal generation and detection using Matlab Simulink	To understand the principles of Amplitude Modulation (AM) with a focus on Single Sideband-Suppressed Carrier (SSB-SC) modulation.
7	**Week 7**: To perform the frequency modulation signal generation and detection using Matlab Simulink	To simulate the generation and detection of FM signals using MATLAB Simulink. Analyze the modulated and demodulated FM signals, examining their characteristics and practical applications.
8	**Week 8**: To perform the operation of FM demodulation with PLL using Matlab Simulink	Frequency Modulation (FM), Spectrum and bandwidth considerations, models in Simulink, PLL in communication systems, VCO, phase detector, and loop filter design, PLL-based FM demodulation
9	**Week 9**: To verify the spectral components of AM and FM using Matlab Simulink	spectral analysis, Double Sideband (DSB) and Single Sideband (SSB) techniques, Spectrum of FM signals, Generating sinusoidal and modulated signals, Time-domain analysis of AM,signals, Time-domain analysis of FM signals
	Week 10: To perform pulse amplitude modulation	Analog and Digital, Pulse Amplitude Modulation, continuous- time and discrete-time signals, PAM modulation, Time-domainrepresentation of PAM

10	and demodulation usingMatlab Simulink	signals, Signal-to-noise ratio (SNR)analysis
11	**Week 11**: To perform the Time division multiplexing using MatlabSimulink	TDM, FDM, CDM, WDM, Synchronous vs. asynchronous TDM,Designing TDM systems in Simulink, Time-domain representation of TDM signals, Signal-to-noise ratio (SNR) analysis
12	**Week 12**: To perform PWM modulation and demodulation using Matlab	PWM, continuous-time and discrete-time signals, PWM signalswith varying duty cycles, Time-domain representation of PWM signals, Signal-to-noise ratio (SNR) analysis

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance Understanding of systems.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to eachcompetency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

- CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
- CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.

A	Continuous Internal Evaluation (CIE)	25 marks
B	Internal Assessment Tests (IAT)	25 marks
Total of CIE (A+B)		50 marks
C	Semester End Examination (SEE)	50 marks
Total of CIE and SEE (A+B+C)		100 marks

CIE Split up for Laboratory based Ability Enhancement Course

Class Work:-A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30 marks (60% of the maximum Marks)

Laboratory Test:-B

CIE Split up for test in Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20 marks (40% of the maximum Marks)
Final CIE for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1.	Scaled Down marks of record / journal-A	60%ofthe maximum	30
2.	Scaled Down marks of test-B	40%ofthe maximum	20
Total		**100%**	**50**

Final CIE Marks = (A) + (B)

SEE for practical Course

1. SEE marks for practical course shall be 50marks

Marks distribution for Experiment based Practical Course for Final SEE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

2. SEE for practical course is evaluated for 100 marks and scored marks shall bescaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allottedto the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1.	Amplitude modulation, Demodulation, DSB,SSB	Students will grasp the fundamental concepts of modulation techniques of signal generation
2.	Working principle of modulation techniques	Students will learn about the working principle of modulation techniques.
3.	Project-Based Learning	Through hands-on projects, students will apply the concepts of modulation techniques in the future projects
4.	Collaboration and CommunicationSkills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.
5.	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BEC408A.1	Design single full phase, ac voltage controller, resonant pulse commutation circuit, buck chopper, AM-DSB,AM-SSB, frequency modulation, frequency demodulation, amplitude modulation demodulation Time division multiplexing ,pulse width modulation of signal generation circuits using Matlab Simulink
M23BEC408A.2	Simulate single full phase, ac voltage controller, resonant pulse commutation circuit, buck chopper, AM-DSB,AM-SSB, frequency modulation, frequency demodulation, amplitude modulation demodulation Time division multiplexing ,pulse width modulation of signal generation circuits using Matlab Simulink
M23BEC408A.3	Analyze signal generation circuits by representing time and frequency domain
M23BEC408A.4	Conduct experiments either individually or in a team and present the corresponding outcomes and process orally and in a written format

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC408A.1	2	3	3	-	3	-	-	-	-	-	-	-	3	-
M23BEC408A.2	-	3	-	-	3	-	-	-	-	-	-	-	3	-
M23BEC408A.3	-	-	3	-	3	-	-	-	-	-	-	-	3	-
M23BEC408A.4	-	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BEC408A	2	3	3	-	3	-	-	-	-	3	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Expt-1	20	10	10	10	**50**
Expt- 2	20	10	10	10	**50**
Expt- 3	20	10	10	10	**50**
Expt-4	20	10	10	10	**50**
Expt-5	20	10	10	10	**50**
Expt-6	20	10	10	10	**50**
Expt-7	20	10	10	10	**50**
Expt-8	20	10	10	10	**50**
Expt-9	20	10	10	10	**50**
Expt-10	20	10	10	10	**50**
Expt-11	20	10	10	10	**50**
Expt-12	20	10	10	10	**50**
Total	20	10	10	10	**50**

10. Future with this Subject

The "Simulink" course in the fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

Artificial Intelligence, Machine Learning and Deep learning

Enhanced integration with AI and ML toolboxes for automated model creation, optimization, andpredictive maintenance. Incorporating AI-driven algorithms for smarter system simulations and real-time decision-making.

- Improved support for IoT applications, enabling seamless integration of Simulink models withIoT devices and platforms.
- Real-time data streaming from IoT sensors to Simulink models for dynamic simulations and analysis.

Real Time Simulation

Improved real-time simulation capabilities for hardware-in-the-loop (HIL) testing and rapid prototyping.
Enhanced support for real-time operating systems and embedded hardware.
Multi-Domain and Multi physics Simulations:
Advanced capabilities for simulating complex, interconnected systems across multiple physicaldomains (e.g, electrical, mechanical, and thermal).
Improved solvers and algorithms for accurate and efficient multi physics simulations

4th Semester	Ability Enhancement Course (AE-IV) POWER ELECTRONICS LABORATORY	M23BEC408B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Circuit Theory	Understanding basic circuit elements like resistors, capacitors, inductors, and transformers is essential; students should be comfortable with analyzing and designing electrical circuits.
2	Semiconductor Devices	Power electronics heavily relies on semiconductor devices such as diodes, transistors (bipolar junction transistors and MOSFETs), thyristors, and IGBTs, knowledge on how these devices work and their characteristics are essential.
3	Analog Electronics	Knowledge of analog electronic circuits, such as amplifiers, operational amplifiers, and feedback systems, is important for designing control and driving circuits in power electronic systems.
4	Control Systems	Power electronics often involves controlling the flow of power from one source to another. Knowledge of control systems and feedback mechanisms is necessary for designing efficient and stable power electronic systems.

2. Competencies

S/L	Competency	KSA Description
1.	Static Characteristics of SCR, MOSFET, IGBT And TRIAC.	**Knowledge:** Understanding the basic operation of an SCR, MOSFET, IGBT and TRIAC. including its layers and how it controls current flow. **Skills:** Proficiency in designing circuits that incorporate SCRs, MOSFET, IGBT and TRIAC ensuring correct triggering and stable operation. Ability to analyze the performance of these devices in circuits, using simulation tools to predict behavior under various conditions. **Attitudes:** Creativity in finding innovative solutions to challenges posed by SCR MOSFET, IGBT and TRIAC characteristics in various applications. Willingness to engage in continuous education through courses, seminars, and reading technical literature.
2.	SCR turn on a circuit usinga synchronized UJT relaxation oscillator.	**Knowledge:** Basic Electronic Components. RC time constants and their effect on charging and discharging in circuits. **Skills:** Designing the UJT relaxation oscillator circuit to produce the desired frequency. Integrating the UJT oscillator with the SCR gate. **Attitudes:** Carefully following circuit schematics and ensuring all connections are correct. Adapting and optimizing the circuit as needed.
5.	SCR digital triggering circuit for a single-phase controlled rectifier and AC voltage regulator.	**Knowledge:** Detailed understanding of SCRs, microcontrollers (e.g., Arduino, PIC), resistors, capacitors, diodes, and opto couplers. Knowledge of component symbols, characteristics, and datasheets. **Skills:** Designing the SCR triggering circuit to control the firing angledigitally. Creating a schematic that integrates the microcontroller with the SCR and opto coupler for isolation. **Attitudes:** Carefully following circuit schematics and ensuring all connectionsare correct.
6.	Single phase controlled full wave rectifier with R load, R –L load, R-L-Eload with and without freewheeling diode.	**Knowledge:** Electronic Components, Circuit Theory, Controlled RectifierPrinciples. **Skills:** Designing controlled rectifier circuits for different load types. Integrating freewheeling diodes and understanding their placementand effect. **Attitudes:** Ensuring accurate component values and connections in the circuit.

7.	AC voltage controller using TRIAC and DIAC Combination connected to R and RL loads.	**Knowledge:** Understanding the operation, triggering methods, and characteristics.of TRIACs and DIACS. Principles of phase control for varying the effective voltage delivered to the load. **Skills:** Designing the phase control circuit using TRIAC and DIAC. **Attitudes:** Ensuring accurate component values and connections in the circuit.
8.	Speed control of DC motorusing single semi converter.	**Knowledge:** Principles of rectification, especially half-wave and full-wave rectification, Understanding of semi-converters and their operation. **Skills:** Designing the semi-converter circuit for controlling the DC motor speed. **Attitudes:** Ensuring accurate component values and connections in the circuit.
9.	Speed control of stepper motor.	**Knowledge:** Types of DC motors (shunt, series, and compound), characteristics,and control methods. **Skills:** Using simulation tools (e.g., SPICE) to model and analyze the motorcontrol circuit. **Attitudes:** Ensuring accurate component values and connections in the circuit.
10	Speed control of universal motor using ac voltage regulator.	**Knowledge:** Types of DC motors (shunt, series, and compound), characteristics, and control methods **Skills:** Using simulation tools (e.g., SPICE) to model and analyze the motorcontrol circuit. **Attitudes:** Ensuring accurate component values and connections in the circuit.
11	Speed control ofa separatelyexcited D.C.Motor using an IGBT or MOSFET Chopper.	**Knowledge:** Designing of different Types of DC motors using IGBT, MOSFET(shunt, series, and compound), characteristics, and control methods. **Skills:** Using simulation tools (e.g., SPICE) to model and analyze the motorcontrol circuit. **Attitudes:** Ensuring accurate component values and connections in the circuit.
12	Single phase MOSFET/IGBT based PWM inverter.	**Knowledge:** Feedback Control: Basics of feedback mechanisms to maintain desired motor speed. Pulse Width Modulation (PWM): Basic concepts if used incombination with SCRs for finer control. **Skills:** Using simulation tools (e.g., SPICE) to model and analyze the motor control circuit. **Attitudes:** Ensuring accurate component values and connections in the circuit.

3. Syllabus

POWER ELECTRONICS LABORATORY SEMESTER – IV			
Course Code	**M23BEC408B**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total number of Lab sessions	**12**	Total marks	**100**
Credits	**1**	Exam Hours	**3**

Course objectives: This course will enable students to:

- To understand static characteristics of semiconductor devices to discuss their performance.
- To understand the Triggering of SCR by different methods
- To study and verify the performance of single phase controlled full wave rectifier and ACvoltage

controller with R and RL loads.
- To study the Controlling of speed of a DC motor, universal motor and stepper motors.
- To understand the performance of single phase full bridge inverter connected to resistiveload.

Sl. No.	Experiments
1	Static Characteristics of SCR.
2	Static Characteristics of MOSFET and IGBT.
3	Characteristic of TRIAC.
4	SCR turn on circuit using synchronized UJT relaxation oscillator.
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode.
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8	Speed control of DC motor using single semi converter.
9	Speed control of stepper motor.
10	Speed control of universal motor using ac voltage regulator.
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12	Single phase MOSFET/IGBT based PWM inverter.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Static Characteristics of SCR	Understand the working principle and V-I characteristics of SCR.
2	Week 2-3: Static Characteristicsof MOSFET and IGBT.	Understand the working principle of and V-I characteristics of MOSFET and BJT, ensuring correct biasing, thermal management, and efficient operation.
3	Week 3-4: Characteristicsof TRIAC.	Understand the working principle and V-I characteristics of TRIAC.
4	Week 4-5: SCR turns on acircuit usingasynchronized UJT relaxation oscillator.	Understanding the concept of UJT as a relaxation oscillator, RC time constants and their effect on charging anddischarging in circuits. and Integrating the UJT oscillator with the SCR gate.
5	Week 5-6: SCR digitaltriggering circuit for a single phase controlled rectifier and acvoltage regulator.	Understand the digital triggering circuit, Design the SCR triggering circuit to control the firing angle
6	Week 6-7: Single phase controlled fullwave rectifier with R load, R –L load, R-L-E load with andwithout freewheeling diode.	Understanding the principle of Controlled Rectifier Principles with different load types.
7	Week 7-8: AC voltagecontroller using TRIAC andDIAC Combination connected to Rand RL loads.	Understand the working of AC voltage controllers using TRIAC and DIAC.
8	Week 8-9: Speed control of DC motor using single semi converter.	Understanding of semi-converters and their operation to control the speed of DC motor.
9	Week 9-10: Speed controlof stepper motor.	Understanding of semi-converters and their operation to control the speed of Stepper motor
10	Week 10-11: Speed control of Universal motor using ac voltage regulator.	Understanding types of DC motors (shunt, series, and compound), characteristics, control methods and to control the speed of Universal motor.
11	Week 11-12:	Understanding types of DC motors (shunt, series, and compound),

	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.	characteristics, control methods and to control the speed of separately excited DC motor.
12	Week 12-13: Single phase MOSFET / IGBT based PWM inverter.	Understand Single phaseMOSFET/IGBT based PWM inverter.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of power electronics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to eachcompetency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple Representations	Introduce topics in various representations to reinforce competencies
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1. CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2. CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3. The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluationand grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

CIE Split up for Laboratory based Ability Enhancement Course

Class Work:-A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result andProcedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30 marks (60% of the maximum Marks)

Laboratory Test:-B

CIE Split up for test in Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result andProcedure	60%	30

2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20 marks (40% of the maximum Marks)

Final CIE for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal-A	60%ofthe maximum	30
2	Scaled Down marks of test-B	40%ofthe maximum	20
Total		**100%**	**50**

Final CIE Marks = (A) + (B)

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding Power Electronics Fundamentals and its applications.	Students will grasp the fundamental concepts of Power Semiconductor devices, working principle of different typesconversion techniques and its applications.
2	Designing different types of circuits like choppers, AC voltage controllers, Inverters rectifiers.	Students will learn to design and implement different types of circuits like choppers, AC voltage controllers, Invertersrectifiers.
3	Proficiency in designing of circuits.	Students will become proficient in design and implement different types of AC and DC circuits
4	Project-Based Learning	Through hands-on projects, students will apply their knowledge of Power electronics to design, implement, simple and complex circuits, reinforcing their understanding of theoretical concepts
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share Ideas, and solve problems collectively.
6	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated with digital design, including respecting intellectual property rights, ensuring design reliability and security, and adhering to industry standards and best practices.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

COs	Description
M23BEC408B.1	Explain the operation of power electronic devices and its applications.
M23BEC408B.2	Analyze the V-I characteristics of SCR, DIAC, MOSFET, IGBT and TRIAC.
M23BEC408B.3	Design the different power circuit for firing and speed control of motors Using power devices.
M23BEC408B.4	Conduct investigation of the complete Experimental process of power semiconductor devices and circuits.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
M23BEC408B.1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC408B.2	3	2	-	-	-	-	-	-	-	-	-	-	3	3
M23BEC408B.3	3	2	2	-	-	-	-	-	-	-	-	-	3	2
M23BEC408B.4	3	2	-	-	-	-	-	-	3	3	-	-	3	-
M23BEC408B	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**3**	**2.5**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Expt-1	20	10	10	10	50
Expt- 2	20	10	10	10	50
Expt- 3	20	10	10	10	50
Expt-4	20	10	10	10	50
Expt-5	20	10	10	10	50

Expt-6	20	10	10	10	50
Expt-7	20	10	10	10	50
Expt-8	20	10	10	10	50
Expt-9	20	10	10	10	50
Expt-10	20	10	10	10	50
Expt-11	20	10	10	10	50
Expt-12	20	10	10	10	50
Total	20	10	10	10	**50**

10. Future with this Subject

The "Power electronics Laboratory" course in the Fourth semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of digital systems. Here are some notable contributions:

a. **Control Systems:** Control Systems in Power Electronics focus on designing algorithms andcontrol strategies to regulate power converters. They play a crucial role in ensuring the stability and efficiency of power systems, contributing to advancements in renewable energy and electric vehicle technologies.

b. **The convergence of Power Electronics with Internet of Things (IoT) and Artificial Intelligence (AI):** The convergence of Power Electronics with Internet of Things (IoT) and Artificial Intelligence (AI) promises unprecedented efficiency and control, redefining how energy is generated, distributed, and consumed. The proliferation of wide- semiconductors and advanced materials further accelerates the pace of innovation, enabling smaller, more efficient devices.
Power Electronics, in the future, is not merely a component but an integral force shapingsustainable energy solutions. As we navigate this dynamic evolution, the adaptability and foresight within Power Electronics underscore its pivotal role in shaping a more energy-efficient and technologically advanced future. The synergy of these emerging technologies positions Power Electronics at the forefront of the technological revolution, ensuring a future that is not only connected but also environmentally sustainable.

c. **Automotive Electronics:** The automotive industry is undergoing a significant transformation with the rise of electric vehicles (EVs). Power Electronics is at the forefront of this revolution, powering EVs with efficient motor drives and energy storage systems. Professionals in this field will find abundant opportunities as the demand for electric transportation continues to grow.

d. **Advanced Courses:** One of the key advantages of a career in Power Electronics is its versatility. Professionals in this field can seamlessly transition between industries, working on diverse projects ranging from developing power-efficient consumer electronics to designing advanced power systems for space exploration.

e. **Project Work and Research:** a career in Power Electronics presents a world of opportunitiesfor individuals passionate about shaping the future of technology. From designing efficient power systems to contributing to the renewable energy revolution, Power Electronics professionals are at the forefront of innovation. The field's global demand, versatility, andcontinuous learning opportunities make it an exciting and rewarding choice for those aspiring to make a meaningful impact in the realm of electronic power. As we look towards the future, Power Electronics will undoubtedly continue to play a vital role in shaping a more connected, sustainable, and electrifying world.

f. **Industry Applications:** The course provides practical skills that are directly applicable inindustries related to controlling of equipments, AI and IOT, and more. Graduates are well- prepared to contribute to industries developing Electronics engineers.
In summary, the "Power Electronics" course serves as a stepping stone, equipping students with foundational knowledge and skills that are essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

4th Semester	Ability Enhancement Course (AE-IV) SIGNALS & SYSTEM LABORATORY	M23BEC408C

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Mathematics	Calculus, Linear Algebra and Differential Equations.
2.	Basic Electronics	Types of message signals used in communication process.
3.	Programming Skills	Knowledge on Programming Languages like Python and C.

2. Competencies

S/L	Competency	KSA Description
1.	Knowledge Generation of elementary signals	**Knowledge**: Proficiency in basics of signals like exponential, periodic and sinusoidal. **Skills**: Applying basic mathematics and programming skills to find effective solutions. **Attitudes:** Methodical approach to problem-solving, Programming and SimulationSkills, Critical Thinking.
2.	Understanding of difference equations in LTI System.	**Knowledge:** Understanding how to simulate difference equations, find frequency responses, perform convolutions, and determine poles and zeros of LTI systems in MATLAB demonstrates proficiency in analyzingand manipulating discrete-time and continuous-time systems, and essential skills in signal processing and control engineering. **Skills:** Developing MATLAB codes for simulating difference equations, analyzing frequency responses, performing convolutions, and determining poles and zeros of LTI systems enhances proficiency in signal processing, system analysis, and control theory, essential skills for engineers and researchers in various fields. **Attitudes:** Mastering MATLAB implementations for simulating difference equations, analyzing frequency responses, performing convolutions, and determining poles and zeros fosters an attitude of precision, problem-solving, and curiosity in exploring the behavior of linear time-invariant systems.
3.	Knowledge on Sampling and reconstruction	**Knowledge:** Gaining knowledge in writing MATLAB code to generate sampled signals from discrete and continuous-time signals involves understandingsampling theory, signal discretization methods, and digital signal processing techniques, essential for accurately representing analog signals in digital systems. **Skills:** Developing skills in MATLAB coding for generating sampled signals from discrete and continuous-time signals enhances proficiency in signal processing, numerical methods, and digital-to-analog conversion, crucial for accurately capturing and representing analog phenomena in digital systems. **Attitudes:** Mastering the MATLAB implementation of generating sampled signals from discrete and continuous-time domains fosters an attitude of precision, creativity, and adaptability, encouraging a deeper understanding and appreciation for the interplay between theoretical concepts and practical applications in signal processing.
4.	Knowledge on Z transform	**Knowledge:** Gaining competency in writing MATLAB code to find Z-transforms and their inverses, as well as solving difference equations or systems of linear equations using Z-transforms, entails understanding discrete-time signal representation in the Z-domain, manipulation of Z-transform properties, and application of inverse Z-transform techniques. **Skills:** Developing skills in MATLAB coding for Z-transform computation, inversion, and solving difference equations or systems of linear equationsin the Z-domain enhances proficiency in digital signal processing, system analysis, and control theory, crucial for designing and analyzing discrete-time systems. **Attitudes:** Mastering the MATLAB implementation of Z-transform computations and solving difference equations cultivates an attitude of meticulousness, problem-solving, and a deep appreciation for the mathematical foundations underlying discrete-time signal processing and system analysis.

3. Syllabus

SIGNALS AND SYSTEM LAB SEMESTER – IV			
Course Code	**M23BEC408C**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total number of Lab sessions	**12**	Total marks	**100**
Credits	**1**	Exam Hours	**3**

Course objectives: This course will enable the students to:

- Classify the signals and understand different operations on signals.
- Recognize the basic signals (both continuous- time and discrete-time) like impulse, unit step,ramp, sinusoids and exponentials, represented both in frequency and time domains.
- Characterize LTI system using impulse response and linear constant coefficient differential equations.
- Represent all types of signals (CT/DT, periodic/non-periodic) in terms of complex
- Define relationship between Z transform and Fourier transform.

Sl. No.	**To realize the following programs using MATLAB software:**
1.	Write a MATLAB code to generate the CTS and DTS Periodic Signals Exponential Signals Sinusoidal Signals
2.	Write a MATLAB code to generate the CTS and DTS Exponentially Damped Sinusoidal Signals Step, Impulse and Ramp functions User defined functions
3.	Write a MATLAB code to simulate difference equation.
4.	Write a MATLAB code to find the frequency response of LTI systems described bydifferential or difference equations.
5.	Write a MATLAB code to perform convolution of signals.
6.	Write a MATLAB code to find the DTFS of the given signal.
7.	Write a MATLAB code to find Poles and Zeros of LTI systems.
8.	Write a MATLAB code to generate sampled signal of a discrete and Continuous-time signal.
9.	Write a MATLAB code to find Z-transform and inverse of the Z-transform.
10.	Write a MATLAB code Solve a given difference equation of linear equations [Z-transform].
11.	Write a MATLAB code to perform amplitude scaling, time scaling and time shifting on a given signal.

Suggested Learning Resources:

1. https://matlab.mathworks.com/
2. https://in.mathworks.com/help/simulink/design-model-architecture.html?s_tid=CRUX_lftnav

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1.	Week 1-2: Generation of elementary signals	To teach elementary signals in MATLAB to students, start with basic signal types like step, ramp, exponential, and sinusoidal functions. Demonstrate how to generate these signals using MATLAB's built-in functions and plotting capabilities. Encourage experimentation with parameters to observe changes in signal characteristics, fostering hands-on learning and understanding of signal behavior.
2.	Week 3-4: Basicoperations on signals	Teach basic signal operations in MATLAB by introducing addition, subtraction, multiplication, and scaling. Show how to perform these operations using MATLAB's array manipulation and arithmeticfunctions. Provide examples illustrating how operations affect signal properties like amplitude, frequency, and phase, reinforcing understanding through practical application and visualization.

3.	Week 5-6: LTI System	Teach LTI differential equations in MATLAB by demonstrating how to model them using state-space representation or transfer functions. Show students how to simulate LTI systems' responses to input signals using MATLAB's ODE solvers. Encourage exploring system dynamics through parameter variations and analyzing responses to Different input stimuli for comprehensive understanding.
4.	Week 7-8: Convolution	Introduce LTI systems in MATLAB by defining system impulse response and convolution operation. Illustrate how to simulate LTI systems using MATLAB's conv function and plot their output responses to different input signals. Encourage experimentation with various system parameters and input signals to understand the effects of LTI systems on signals.
5.	Week 9-10: Sampling	Introduce sampling in MATLAB by explaining Nyquist theorem and Sampling rate concepts. Demonstrate how to generate sampled signals from continuous-time signals using MATLAB's sampling functions. Show aliasing effects through under-sampling examples. Guide students in analyzing sampled signals' properties, such as frequency Content and reconstruction, using MATLAB's tools and visualizations.
6.	Week 11-12: Z transform	Teach Z-transform in MATLAB by illustrating its use in discrete-time signal analysis and system representation. Show how to compute Z- transforms and inverse Z-transforms of signals and systems using MATLAB functions. Demonstrate applications such as frequency response analysis and digital filter design through MATLAB simulations and visualizations, fostering understanding through hands- on practice.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1.	Lecture Method	Utilize various teaching methods within the lecture format to Reinforce competencies.
2.	Video/Animation	Incorporate visual aids like videos/animations to enhance Understanding of the concepts of Signals and System.
3.	Collaborative Learning	Encourage collaborative learning for improved Competency application.
4.	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5.	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6.	Real-World Application	Discuss practical applications to connect theoretical concepts withreal-world competencies.
7.	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to Facilitate deeper understanding of competencies.
8.	Programming Assignments	Assign programming tasks to reinforce practical skills associated with Competencies.

6. Assessment Details (both CIE and SEE)

1. CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in theSEE of the course.
2. CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated fora total of 100 marks, irrespective of its credits.
3. The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluation and grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

CIE Split up for Laboratory based Ability Enhancement Course

Class Work:-A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30 marks (60% of the maximum Marks)

Laboratory Test:-B

CIE Split up for test in Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20 marks (40% of the maximum Marks)

Final CIE for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal-A	60%ofthe maximum	30
2	Scaled Down marks of test-B	40%ofthe maximum	20
Total		**100%**	**50**

Final CIE Marks = (A) + (B)

SEE for practical Course

5. SEE marks for practical course shall be 50marks

Marks distribution for Experiment based Practical Course for Final SEE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

6. SEE for practical course is evaluated for 100 marks and scored marks shall bescaled down to 50 marks.
7. Change of experiment/program is allowed only once and 20% marks allottedto the procedure/write-up part to be made zero.
8. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Understanding signal and system Fundamentals	Students will be able to understand the basics of signals, their operation, systems, and properties.
2	Proficiency in LTI system	Students will learn to analyze impulse response, convolution, stability, and transfer functions for engineering applications
3	Proficiency in LTI system	Students will develop proficient skills for accurate analysis and processingof digital signals.
4	Project-Based Learning	Through hands-on projects, Students will be able to tackle real-world problems by applying theory to design solutions and fostering critical thinking, collaboration, and practical skills in engineering andcommunication technologies.
5	Collaboration and Communication Skills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, and solve problems collectively.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

Cos	Description
M23BEC408C .1	Apply the Basics of signals and systems to write MATLAB code to represent DTS and CTS Signals, Solve difference equation, Z-transform and LTI system.
M23BEC408C .2	Simulate the experiments on Basics of signals and systems to write MATLAB code to represent DTS and CTS Signals, Solve difference equation, Z-transform and LTI system using

	MATLAB software.
M23BEC408C .3	Conduct experimental results/process both orally and in written form.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC408C .1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC408C .2	3	3	-	-	3	-	-	-	3	-	-	-	3	-
M23BEC408C .3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
M23BEC408C	3	3	-	-	3	-	-	-	3	3	-	-	3	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Expt-1	20	20	10	50
Expt- 2	20	20	10	50
Expt- 3	20	20	10	50
Expt-4	20	20	10	50
Expt-5	20	20	10	50
Expt-6	20	20	10	50
Expt-7	20	20	10	50
Expt-8	20	20	10	50
Expt-9	20	20	10	50
Expt-10	20	20	10	50
Expt-11	20	20	10	50
Expt-12	20	20	10	50
Total	20	20	10	**50**

10. Future with this Subject

The "Signals and Systems" course in the fourth semester of the B.E program lays a strongfoundation for several future courses in the undergraduate program. The contributions of this subject extend across various areas, enhancing the students' understanding and skills in the field of signal processing. Here are some notable contributions:

- **Digital Signal Processing (DSP):** Signals and systems concepts form the foundation for understanding DSP algorithms and techniques
- **Communication Systems:** Knowledge of signals and systems is essential for analyzing and designing communication systems, including modulation, demodulation, and channel coding
- **Control Systems**: Understanding signal processing and system dynamics is crucial for analyzing and designing control systems for various applications
- **Image Processing**: Signals and systems principles are fundamental to image processing techniques such as filtering, compression, and enhancement
- **Biomedical Engineering**: Signal processing techniques are essential for analyzing physiological signals in biomedical applications like medical imaging and biosignal analysis
- **Project Work and Research:** Signals and systems provide foundational knowledge and analytical tools essential for project work and research across various domains. They enable precise analysis and design of systems, facilitating tasks such as signal processing, control systems, and communications. Mastery of these concepts allows for the development and implementation of efficient algorithms and models. They support interdisciplinary applications, enhancing projects in fields like biomedical engineering, robotics, and telecommunications.Overall, they equip researchers with the skills to tackle complex problems and innovate in technology-driven areas.

4th Semester	Ability Enhancement Course (AE-IV) RASPBERRY PI WITH PYTHON	M23BEC408D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Fundamental Electronics Knowledge	Knowledge of sensors, and actuators and understanding of their working principle.
2	Embedded Systems	Knowledge of Embedded systems and interfacing of sensors andactuators with controller.
3	Programming Fundamentals	Basic programming skills, as the course involves using Python and network programming using protocols.
4	Data Sheet Reading	Proficiency in reading and understanding datasheets of Raspberry Pi to interpret pin configuration and specifications.

2. Competencies

S/L	Competency	KSA Description
1	Interfacing I/O devices and communication modules	**Knowledge:** • Understanding of different types of I/O devices and sensors such as LEDs, buzzers, push buttons, digital sensors (IR/LDR), and DHT11 sensors. • Knowledge of communication modules like Bluetooth and their role in IoT. • Familiarity with Python libraries for Bluetooth communication. **Skill:** • Proficiency in writing Python programs to interface with I/O devices and sensors. • Ability to configure and use communication modules to send and receive data. • Skill in reading and interpreting sensor data. **Attitude:** • Methodical approach to integrating and testing sensor modules. • Appreciation for the role of communication modules in IoT. • Curiosity and willingness to learn about embedded systems and programming
2	Remote monitoring of data and device control	**Knowledge:** • Understanding of cloud platforms like Thing Speak and communication protocols like MQTT, UDP, and TCP. • Knowledge of data uploading, retrieval, and real-time monitoring techniques. **Skills:** • Ability to write Python programs to interact with cloud platforms. • Competence in using APIs to upload and retrieve data from Thing Speak. • Proficiency in configuring Raspberry Pi as a server (UDP/TCP) to communicate with clients. **Attitudes:** • Curiosity and willingness to learn about embedded systems and programming
3	Networking and Communication Protocols	**Knowledge:** • Understanding networking concepts and protocols (TCP, UDP, etc.) • Understanding client-server architecture and communication models **Skill:** • Ability to create and program TCP and UDP servers on the Raspberry Pi • Ability to handle client requests and respond with appropriate data **Attitude:** • Willingness to learn and adapt to different communication protocols

3. Syllabus

RASPBERRY PI WITH PYTHON SEMESTER – IV			
Course Code	**M23BEC408D**	CIE Marks	**50**
Teaching Hours/Week(L:T:P:S)	**0:0:2:0**	SEE Marks	**50**
Total number of Lab sessions	**12**	Total marks	**100**
Credits	**1**	Exam Hours	**3**

Course objectives:

The course aims to:

- Provide hands-on experience with Raspberry Pi, a versatile single-board computer.
- Learn interfacing of various sensors and actuators with Raspberry Pi.
- Develop skills in programming Raspberry Pi using Python for different applications.
- Introduce concepts of Internet of Things (IoT) and cloud integration using Raspberry Pi.
- Enhance understanding of communication protocols (e.g., Bluetooth, UDP, TCP) using Raspberry Pi.

Sl. No.	Experiments
1	i) To interface LED/Buzzer with Raspberry Pi and write a program to 'turn ON' LED for 1sec after every 2 seconds. ii) To interface Pushbutton/Digital sensor (IR/LDR) with Raspberry Pi and write a program to 'turn ON 'LED when push button is pressed or at sensor detection.
2	i) To interface Digital sensor (IR/LDR) with Raspberry Pi and write a program to 'turnON' LED at sensor detection. ii) To interface DHT11 sensor with Raspberry Pi and write a program to print temperature and humidity readings.
3	To interface OLED with Raspberry Pi and write a program to print temperature and humidity readings on it.
4	To interface motor using relay with Raspberry Pi and write a program to 'turn ON'Motor when push button is pressed.
5	Write a program on Raspberry Pi using ADC to control LED/Motor.
6	To interface Bluetooth with Raspberry Pi and write a program to send sensor data tosmart phone using Bluetooth.
7	To interface Bluetooth with Raspberry Pi and write a program to turn LED ON/OFFWhen '1'/'0' is received from smart phone using Bluetooth.
8	Write a program on Raspberry Pi to upload and retrieve temperature and humidity datato and from things peak cloud.
9	Write a program on Raspberry Pi to publish temperature data to MQTT broker.
10	Write a program to create UDP server on Raspberry Pi and respond with humidity datato UDP client when requested.
11	Write a program to create TCP server on Raspberry Pi and respond with humidity data to TCP client when requested.
12	Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.

Suggested Learning Resources:

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", UniversityPress.
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: Apractical Approach", ETI Labs.
3. Pethuru Raj and Anupama C Raman, "The Internet of Things: Enabling Technologies,Platforms, and Use Cases", CRC Press Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi Adrian McEwen, "Designing the Internet of Things", Wiley.
4. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-5: Experiments 1 to 5	Interface LED, Buzzer, Pushbutton, LDR, and IR sensors, DHT11 sensor, OLED, and Relay with motor with Raspberry Pi and workfor different applications.
2	Week 6-7: Experiments 6 and 7	Interface Bluetooth of the smart phone with Raspberry PI formonitoring and control of temperature sensed by DHT11 sensor.
3	Week 8-9:	Uploading and retrieving sensor data to/from the cloud using IOT

	Experiments 8 & 9	platform Thing Speak
4	Week 10-13: Experiments 10 to 12	Configuring Raspberry PI as a client or server to send/receive datausing different protocols.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of sensors, actuators, and protocols working.
3	Collaborative Learning	Encourage students to work in pairs or small groups to foster collaboration and peer-to-peer learning.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Formative, Summative and other Assessments shall be conducted as per the Institution calendar of events in all the courses of the programme offered to the students, within the framework of Scheme of Teaching and Evaluation.

Assessments and Evaluation Process:

1. CIE and SEE constitute the major evaluations prescribed for each course, with only those students maintaining a minimum standard in CIE are permitted to appear in the SEE of the course.
2. CIE and SEE are to carry 50% weightage each, to enable the course to be evaluated for a total of 100 marks, irrespective of its credits.
3. The evaluation system of the programme is comprehensive and continuous during the entire period of the Semester, by the faculty who is teaching the course. For a course, the evaluationand grading will be on the following parameters:

A	**Continuous Internal Evaluation (CIE)**	**25 marks**
B	**Internal Assessment Tests (IAT)**	**25 marks**
Total of CIE (A+B)		**50 marks**
C	**Semester End Examination (SEE)**	**50 marks**
Total of CIE and SEE (A+B+C)		**100 marks**

CIE Split up for Laboratory based Ability Enhancement Course

Class Work:-A

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 30 marks (60% of the maximum Marks)
Laboratory Test:-B

CIE Split up for test in Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Write-up, Conduction, result and Procedure	60%	30
2	Viva-Voce	40%	20
Total		**100%**	**50**

The Test marks should be scaled down to 20 marks (40% of the maximum Marks)

Final CIE for Laboratory based Ability Enhancement Course

SL. No.	Description	% of Marks	In Marks
1	Scaled Down marks of record / journal-A	60 % of the maximum	30
2	Scaled Down marks of test-B	40 % of the maximum	20
Total		**100%**	**50**

Final CIE Marks = (A) + (B)

SEE for practical Course

Marks distribution for Experiment based Practical Course for Final SEE

SL. No.	Description	% of Marks	Marks
1	Write-up, Procedure	20%	20
2	Conduction and result	60%	60
3	Viva-Voce	20%	20
Total		**100%**	**100**

1. SEE marks for practical course shall be 50marks
2. SEE for practical course is evaluated for 100 marks and scored marks shall bescaled down to 50 marks.
3. Change of experiment/program is allowed only once and 20% marks allottedto the procedure/write-up part to be made zero.
4. Duration of SEE shall be 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Interfacing Input / Output Devices	Students will understand the principles of interfacing LEDs, buzzers, push buttons, relays, motor, and digital sensors (IR, LDR) with the Raspberry Pi.
2	Sensor Data Acquisition and Display	Students will learn to interface and read data from analog sensorslike temperature and humidity sensors (DHT11) using Raspberry Pi and Python. Students will develop programs to display sensor data on OLED displays or other output devices connected to the Raspberry Pi.
3	Proficiency in Python Syntax	Students will become proficient in writing Python code on Raspberry Pi for various applications
4	Collaboration and CommunicationSkills	Students will work collaboratively in teams on design projects, enhancing their ability to communicate effectively, share ideas, andsolve problems collectively.

8. Course Outcomes (COs) and Mapping with POs/ PSOsCourse Outcomes (COs)

COs	Description
M23BEC408D.1	**Explain** the fundamental concepts and working principles of sensors, actuators, and communication modules used with Raspberry Pi
M23BEC408D.2	**Implement** programs to interface various sensors and actuators with Raspberry Pi for specific tasks like monitoring and control.
M23BEC408D.3	**Create** network-based applications using MQTT, TCP, UDP protocols for data exchange and remote monitoring of embedded systems.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEC408D.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BEC408D.2	3	3	3	-	2	-	-	-	2	2	-	2	3	3
M23BEC408D.3	3	3	3	-	2	-	-	-	2	2	-	2	3	3
M23BEC408D	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**2**	**2**	**-**	**2**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Experiment-1	20	30		50
Experiment - 2	20	30		50
Experiment - 3	20	30		50
Experiment -4	20	30		50
Experiment -5	20	30		50
Experiment -6	20	30		50
Experiment -7	20	30		50
Experiment -8	20	10	20	50
Experiment -9	20	10	20	50

Experiment -10	20	10	20	50
Experiment -11	20	10	20	50
Experiment -12	20	10	20	50
Total	20	21	9	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	**Total**
Experiment	40	30	30	100
Total	40	30	30	**100**

10. Future with this Subject

The field of Raspberry Pi and Python programming has immense potential for future applications and advancements. With the increasing demand for Internet of Things (IoT) devices, edge computing, and embedded systems, this subject will play a crucial role in shaping the future of various industries and domains. Here are some potential future prospects and applications:

- **Smart Home and Home Automation**: Raspberry Pi and Python can be used to develop intelligent home automation systems, allowing users to control and monitor various aspects of their homes, such as lighting, temperature, security, and appliances, through a centralized system or mobile applications.
- **Industrial Automation and Control**: The combination of Raspberry Pi and Python can be leveraged in industrial settings for automation, process control, and monitoring applications. These systems can be used for tasks such as data acquisition, machine control, and predictive maintenance, leading to increased efficiency and productivity.
- **Robotics and Autonomous Systems**: The affordability and versatility of Raspberry Pi make it an attractive platform for developing robotics applications and autonomous systems. Python programming can be used for tasks such as computer vision, motion control, and decision-making algorithms in robots and drones.
- **Internet of Things (IoT) Systems**: The Internet of Things is a rapidly growing field, and Raspberry Pi and Python can be used to create IoT devices, sensors, and gateways, enabling seamless integration and communication between physical and digital systems.

4th Semester	Ability Enhancement Course (AE) UNIVERSAL HUMAN VALUES COURSE (UHV)	M23BUHK409

Universal Human Values Course (UHV)			
Course Code	**M23BUHK409**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**12**	Total Marks	**100**
Credits	**01**	Exam Hours	**01 Hour**

Course objectives:

This course is intended to:

- To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and the movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.
- This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Teaching-Learning Process (General Instructions)

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

The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.

In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied skills.

State the need for UHV activities and their present relevance in society and provide real-life examples.

Support and guide the students in self-study activities.

You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.

This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.

Encourage the students for group work to improve their creative and analytical skills.

Module-1

Introduction to value Education (3 hours)

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

Module-2

Harmony in the Human Being **(3hours)**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health

Module-3

Harmony in the Family and Society: (3hours)

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationships, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationships, Understanding Harmony in Society, Vision for the Universal Human Order

Module-4

Harmony in the Nature/Existence: (3hours)

Understanding Harmony in Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony inExistence

Module-5

Implications of the Holistic Understanding – a Look at Professional Ethics: (3hours)

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics

Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards
Value-based Life and Profession

Course outcome:

At the end of the course, students are expected to become more aware of themselves, and their surroundings (family,society, nature);

CO1: They would become more responsible in life, and in handling problems with sustainable solutions, whilekeeping human relationships and human nature in mind.

CO2: They would have better critical ability.

CO3: They would also become sensitive to their commitment towards what they have understood (human values,human relationship and human society).

CO4: It is hoped that they would be able to apply what they have learnt to their own self in different day-to-daysettings in real life, at least a beginning would be made in this direction.

Expected to positively impact common graduate attributes like:

1. Ethical human conduct
2. Socially responsible behaviour
3. Holistic vision of life
4. Environmentally responsible work
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

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). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous InternalEvaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. 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
3. Any two assignment methods mentioned in the regulations, 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.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

The sum of two tests, two assignments, will be out of 100 marks and will be scaled down to 50 marks.

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 Examinations (SEE)

SEE paper shall be set for **50 questions**, each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.** The student has to secure a minimum of 35% ofthe maximum marks meant for SEE.

Suggested Learning Resources:

Books for READING:

Text Book and Teachers Manual

1. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G PBagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034-47-1.
2. The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, RAsthana, G

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal

10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth –Club of Rome's report, Universe Books.
16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford UniversityPress
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), EasternEconomy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

1. Value Education websites,
2. https://www.uhv.org.in/uhv-ii
3. http://uhv.ac.in
4. ttp://www.uptu.ac.in
5. Story of Stuff.
6. http://www.storyofstuff.com
7. Al Gore, An Inconvenient Truth, Paramount Classics, USA
8. Charlie Chaplin, Modern Times, United Artists, USA
9. IIT Delhi, Modern Technology – the Untold Story
10. Gandhi A., Right Here Right Now, Cyclewala Productions
11. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
12. https://fdp-si.aicte-india.org/8dayUHV_download.php
13. https://www.youtube.com/watch?v=8ovkLRYXIjE
14. https://www.youtube.com/watch?v=OgdNx0X923I
15. https://www.youtube.com/watch?v=nGRcbRpvGoU

https://www.youtube.com/watch?v=sDxGXOgYEKM

4th Semester	Non Credit Mandatory Course (NCMC) NATIONAL SERVICE SCHEME (NSS)	M23BNSK410

National Service Scheme (NSS)			
Course Code	**M23BNSK410**		
Number of Lecture Hours/Week(L: T: P: S)	**0:0:2:0**	CIE Marks	**100**
Total Number of Lecture Hours		SEE Marks	**-**
Credits	**0**	Total Marks	**100**
Activities Report Evaluation by College NSS Officer at the end of every semester (3rd to 6th semester)			

Course objectives:

National Service Scheme (NSS) will enable students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem –solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledgein finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions - Pedagogy:

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted sothat the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for NSS activities and its present relevance in the society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documentingstudents' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Contents :

1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.
2. Waste management– Public, Private and Govt organization, 5 R's.
3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4. Water conservation techniques – Role of different stakeholders– Implementation.
5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocationaleducation.
7. Developing Sustainable Water management system for rural areas and implementation approaches.
8. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, SwatchBharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
9. Spreading public awareness under rural outreach programs. (minimum5 programs).
10. Social connect and responsibilities.
11. Plantation and adoption of plants. Know your plants.
12. Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).
13. Govt. school Rejuvenation and helping them to achieve good infrastructure.

NOTE:

Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent ofHOD of the department.

At the end of every semester, activity report should be submitted for evaluation.

Distribution of Activities - Semester wise from 3rd to 6th semester

Sem	Topics / Activities to be Covered
3rd Sem for 25 Marks	1. Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing. 2. Waste management– Public, Private and Govt organization, 5 R's. 3. Setting of the information imparting club for women leading to contribution in social andeconomic issues.
4th Sem for 25 Marks	1. Water conservation techniques – Role of different stakeholders– Implementation. 2. Preparing an actionable business proposal for enhancing the village income and approach forimplementation. 3. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/vocational education.
5th Sem for 25 Marks	1. Developing Sustainable Water management systems for rural areas and implementationapproaches. 2. Contribution to any national-level initiative of the Government of India. Foreg. Digital India,Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc. 3. Spreading public awareness under rural outreach programs. (minimum 5 programs). 4. Social connect and responsibilities.
6th Sem for 25 Marks	1. Plantation and adoption of plants. Know your plants. 2. Organize National integration and social harmony events /workshops /seminars. (Minimum 02programs). 3. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Course outcomes:

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

COs	Description
M23BNSK410.1	Understand the importance of his / her responsibilities towards society.
M23BNSK410.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
M23BNSK410.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
M23BNSK410.4	Implement government or self-driven projects effectively in the field.
M23BNSK410.5	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony ingeneral.

Pedagogy – Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic ddifferences, location, and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	Organic farming, Indian Agriculture (Past, Present, and Future) Connectivity for marketing.	May be individual or team	Farmers land/ Villages/ roadside/ community area /College campus etc	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govt organization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / Proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
6.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	School selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
8.	Contribution to any national-level initiative of the Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

9.	Spreading public awareness under rural outreach programs. (minimum 5 programs). ///// Social connect and responsibilities.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
10.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
11.	Organize National integration and social harmony events /workshops /seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be an individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers / campus etc…	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by an individual to the concerned evaluation authority	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

Plan of Action ((Execution of Activities for Each Semester)

Sl.No	Practice Session Description
1.	Lecture session by NSS Officer
2.	Students' Presentation on Topics
3.	Presentation - 1 , Selection of topic, PHASE – 1
4.	Commencement of activity and its progress - PHASE - 2
5.	Execution of Activity
6.	Execution of Activity
7.	Execution of Activity
8.	Execution of Activity
9.	Execution of Activity
10.	Case study-based Assessment, Individual performance
11.	Sector wise study and its consolidation
12.	Video-based seminar for 10 minutes by each student At the end of the semester with a Report.

- In every semester from 3rd semester to 6th semester, each student should do activities according to thescheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.

Assessment Details:

Weightage	**CIE– 100%**	

<table>
<tr><th>4th Semester</th><th colspan="2">Non Credit Mandatory Course (NCMC)
PHYSICAL EDUCATION</th><th>M23BPEK410</th></tr>
<tr><td colspan="2">Presentation - 1
Selection of topic, PHASE - 1</td><td>10 Marks</td><td rowspan="6">• Implementation strategies of the project (NSS work).
• The last Report should be signed by the NSSOfficer, the HOD, and the principal.
• At last Report should be evaluated by the NSSofficer of the institute.
• Finally, the consolidated marks sheet should be sent to the university and made available atthe LIC visit.</td></tr>
<tr><td colspan="2">Commencement of activity and its progress - PHASE - 2</td><td>10 Marks</td></tr>
<tr><td colspan="2">Case Study-based Assessment Individual Performance with Report</td><td>10 Marks</td></tr>
<tr><td colspan="2">Sector-wise study & its consolidation</td><td>10 Marks</td></tr>
<tr><td colspan="2">Video based seminar for 10 minutes by eachstudent At the end of semester with Report. Activities.</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total marks for the course in each semester</td><td>50 Marks</td></tr>
<tr><td colspan="4">Marks scored for 50 by the students should be Scale down to 25 marks In each semester for CIE entry in theVTU portal.</td></tr>
<tr><td colspan="4">25 marks CIE entry will be entered in University IA marks portal at the end of each semester 3rd to 6th semester,Report and assessment copy should be made available in the department semester wise</td></tr>
<tr><td colspan="4">Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society in general.</td></tr>
<tr><td colspan="4">Suggested Learning Resources:
Books :
1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and manual.
3. Government of India, NSS cell, Activities reports and manual.</td></tr>
</table>

4th Semester	Non Credit Mandatory Course (NCMC) PHYSICAL EDUCATION	M23BPEK410

PHYSICAL EDUCATION (SPORTS & ATHLETICS) (M23BPEK410)
SEMESTER - IV
Course Outcomes: At the end of the course, the student will be able to CO1: Understand the ethics and moral values in sports and athletics. CO2: Perform in the selected sports or athletics of the student's choice. CO3: Understand the roles and responsibilities of organisation and administration of sports and games.
Module-1
Ethics and Moral Values (5 hours) Ethics in Sports Moral Values in Sports and Games
Module-2
Specific Games (Any one to be selected by the student) (20 hours) Volleyball — Attack, Block, Service, Upper Hand Pass and Lower Hand Pass. Throwball — Service, Receive, Spin attack, Net Drop & Jump throw. Kabaddi — Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. Kho-Kho — Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. Table Tennis — Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. Athletics (Track / Field Events) — Any event as per availability of Ground.
Module-3
Role of Organisation and administration (5 hours)

Scheme and Assessment for auditing the course and Grades:

Sl. No.	Activity	Marks
1.	Participation of student in all the modules	**20**
2.	Quizzes — 2, each of 15 marks	**30**
3.	Final presentation/exhibition / Participation in competitions/practical on specific tasks assigned to the students	**50**
	Total	**100**

4th Semester	Non Credit Mandatory Course (NCMC) YOGA	M23BYOK 410

Yoga			
Course Code	M23BYOK 410		
Number of Lecture Hours/Week(L: T: P: S)	0:0:2:0	CIE Marks	100
Total Number of Lecture Hours		SEE Marks	-
Credits	0	Total Marks	100
Evaluation Method: Objective type Theory / Practical / Viva-Voce			

Course objectives:

1. To enable the student to have good Health.
2. To practice mental hygiene.
3. To possess emotional stability.
4. To integrate moral values.
5. To attain a higher level of consciousness.

The Health Benefits of Yoga

The benefits of various yoga techniques have been supposed to improve

- body flexibility,
- performance,
- stress reduction,
- attainment of inner peace, and
- self-realization.

The system has been advocated as a complementary treatment to aid the healing of several ailments such as

- coronary heart disease,
- depression,
- anxiety disorders,
- asthma, and
- extensive rehabilitation for disorders including musculoskeletal problems and traumatic brain injury.

The system has also been suggested as behavioral therapy for smoking cessation and substanceabuse (including alcohol abuse).

If you practice yoga, you may receive these physical, mental, and spiritual benefits:

- Physical

1. Improved body flexibility and balance
2. Improved cardiovascular endurance (stronger heart)
3. Improved digestion
4. Improved abdominal strength
5. Enhanced overall muscular strength
6. Relaxation of muscular strains
7. Weight control
8. Increased energy levels
9. Enhanced immune system

- Mental

1. Relief of stress resulting from the control of emotions
2. Prevention and relief from stress-related disorders
3. Intellectual enhancement, leading to improved decision-making skills

- Spiritual

1. Life with meaning, purpose, and direction
2. Inner peace and tranquility

- Contentment

YOGA Syllabus

Semester IV

- Patanjali's Ashtanga Yoga, its need and importance.
- Yama : Ahimsa, satya, asteya, brahmacarya, aparigraha.
- Niyama :shoucha, santosh, tapa, svaadhyaya, Eshvarapranidhan
- Suryanamaskar12 count- 4 rounds of practice
- Asana, Need, importance of Asana. Different types of asana. Asana its meaning by name, technique,precautionary measures and benefits of each asana.
- Different types of Asanas
  1. Sitting
     - Sukhasana
     - Paschimottanasana
  2. Standing
     - Ardhakati Chakrasana
     - Parshva Chakrasana
  3. Prone line
     - Dhanurasana
  4. Supine line
     - Halasana
     - Karna Peedasana
- Meaning, importance and benefits of Kapalabhati.
- 40 strokes/min 3 rounds
- Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionarymeasures and benefits of each Pranayama.
- Pranayama
  1. Suryanuloma –Viloma
  2. Chandranuloma-Viloma
  3. Suryabhedana
  4. Chandra Bhedana
  5. Nadishodhana

Course outcomes :

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

- Understand the meaning, aim and objectives of Yoga.
- Perform Suryanamaskar and able to Teach its benefits.
- Understand and teach different Asanas by name, its importance, methods and benefits.
- Instruct Kapalabhati and its need and importance.
- Teach different types of Pranayama by its name, precautions, procedure and uses
- Coach different types of Kriyas , method to follow and usefulness.

Assessment Details (both CIE and SEE)

- Students will be assessed with internal test by a. Multiple choice questions b. Descriptive type questions (Two internal assessment tests with 25 marks/test).
- Final test shall be conducted for whole syllabus for 50 marks.
  Continuous Internal Evaluation shall be for 100 marks (including IA test)

Suggested Learning Resources:

Books:

1. Yogapravesha in Kannada by Ajitkumar
2. Light on Yoga by BKS Iyengar
3. Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly
4. Yoga Instructor Course hand book published by SVYASA University, Bengaluru
5. Yoga for Children –step by step – by Yamini Muthanna

Web links and Video Lectures (e-Resources):Refer links

https://youtu.be/KB-TYlgd1wE

https://youtu.be/aa-TG0Wg1Ls

4th Semester	Basic Science Course (BS) DIPLOMA MATHEMATICS-2	M23BDIPM411

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Linear Algebra	Linear algebra is a foundational subject in mathematics with wide-ranging applications in science, engineering, computer science, economics, and more. To effectively learn and understand linear algebra, it is important to have Basic Algebra, Geometry, familiarity with summation notation, matrix notation, and other mathematical symbols used in linear algebra.
2.	Higher-Order Differential Equations	To effectively learn and understand higher-order differential equations, one should have a solid foundation in several mathematical areas like Algebraic Manipulations, Differentiation, First-Order ODEs, Familiarity with solving second-order linear differential equations with constant coefficients, including homogeneous and non-homogeneous cases and Partial Fraction.
3.	Probability Theory	Probability theory is an essential subject for engineering students, as it provides the foundation for understanding and modeling uncertainty in various engineering applications. Comfort with simplifying and solving algebraic equations and understanding of basic counting principles, such as the multiplication rule, permutations, and combinations.
4.	Numerical Methods-I & II	Strong foundation in calculus, linear algebra, and basic programming skills. Understanding concepts such as differentiation, integration, matrices, vectors, and algorithms is essential for effectively applying numerical methods in solving mathematical problems.
5.	Previous Course work	Completion of introductory courses in Mathematics or a related field.

2. Competencies

S/L	Competency	KSA Description
1.	Linear Algebra	**Knowledge** Understand the concept of an inverse matrix and how to find it (if it exists), solving systems of linear equations, such as Gaussian elimination and matrix inversion, Understand row reduction techniques and the concepts of row echelon form (REF) and reduced row echelon form (RREF). **Skills** Studying linear algebra effectively requires a combination of specific skills and Analytical Skills to develop the ability to approach and solve a variety of linear algebra problems systematically, **Attitude** Understanding its practical utility can make the subject more engaging and relevant.
2.	Higher-Order Differential Equations	**Knowledge** Understand what constitutes a higher-order differential equation and the significance of the order, differences and implications of homogeneous and non-homogeneous equations, learn to form and solve the characteristic equation to find the general solution of homogeneous equations, **Skills** Develop the ability to systematically approach and solve a variety of differential equations, Recognize and understand the applications of differential equations in other areas of engineering, such as mechanical vibrations, electrical circuits, and control systems, develop skills to model real-world engineering problems using differential equations. **Attitude** It can significantly enhance your learning experience and success in studying higher-order differential equations, some of them are
3.	Probability Theory	**Knowledge** Understanding of basic probability concepts including sample spaces, events, and the axioms of probability, Familiarity with probability rules such as addition and multiplication rules. **Skills** Develop systematic approaches to solving probability problems, Practice breaking down complex problems into simpler parts. Enhance the ability to

		critically evaluate probabilistic models and assumptions. **Attitude** Develop an interest in how probability theory applies to real-world engineering problems, such as reliability analysis, quality control, and risk assessment.
4.	Numerical Methods-I & II	**Knowledge** Students will learn various numerical approximation techniques, such as interpolation, curve fitting, and numerical differentiation and integration, which are essential for approximating functions and data in engineering analysis. **Skills** It helps to acquire practical skills and knowledge that are essential for solving complex engineering problems that may not have analytical solutions. Solving complex engineering problems, analyzing mechanical systems, and optimizing design processes using computational tools and simulations. **Attitude** Methodical approach to testing and validating numerical algorithms for accuracy and efficiency. Adaptability to new tools, libraries, and frameworks that facilitate numerical computations.

3. Syllabus

DIPLOMA MATHEMATICS-II Semester-IV			
Course Code	**M23BDIPM411**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**2:0:0:0**	SEE Marks	**00**
Total Number of Lecture Hours	**20 hours Theory**	Total Marks	**50**
Credits	**00**	Exam Hours	**00**

Course objectives:
The mandatory course M23BDIPM411viz., Additional Mathematics –II aims to provide essential concepts of Linear algebra, Second and higher-order differential equations, insight into Elementary probability theory and Numerical methods.

Module -1: Linear Algebra	
Introduction, Rank of a matrix by elementary row operations, Consistency of system of linear equations, Solution by Gauss Elimination method. Eigenvalues and eigenvectors of a square matrix. Problems.	L1, L2, L3
Module -2: Higher-Order Differential Equations	
Linear homogeneous/nonhomogeneous differential equations of second and higher-order with constant coefficients. Solution by using the inverse differential operator method.	L1, L2, L3
Module -3: Probability Theory	
Introduction, Sample space and Events, Axioms of Probability. Addition and Multiplication theorem. Conditional Probability. Independent events. Baye's theorem, Problems.	L1, L2, L3
Module -4: Numerical Methods -1	
Finite differences, Interpolation/extrapolation using Newton's forward and Backward difference formulae (No derivation), Problems. Solution of polynomial and transcendental equations by Newton–Raphson and Regula–Falsi methods (no derivation), Problems. Numerical Integration: Simson's 1/3 rd rule and 3/8 rule, problems.	L1, L2, L3
Module -5: Numerical Methods -2	
Numerical solution of first-order ordinary differential equations: Taylor's series method, Modified Euler's method, Runge-Kutta method of order 4, Milne's predictor-corrector method. Problems.	L1, L2, L3

Text Books:
Higher Engineering Mathematics: B. S. Grewal, Khanna Publishers, New Delhi, 43rd Ed., 2015.
Reference Books:
1. Higher Engineering Mathematics: V. Ramana, McGraw-Hill Education, 11th Ed.
2. Engineering Mathematics: Srimanta Pal & Subodh C. Bhunia, Oxford University Press, 3rd Reprint, 2016.
3. A textbook of Engineering Mathematics: N.P Bali and Manish Goyal, Laxmi Publications, Latest edition.
4. Higher Engineering Mathematics: H.K. Dass and Er. Rajnish Verma, S. Chand Publication (2014).

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Linear Algebra	Introduction Rank of a matrix by elementary row operations Consistency of system of linear equations Problems Solution by Gauss Elimination method. problems Eigenvalues and eigenvectors of a square matrix. Problems.
2	Week 3-4: Higher-Order Differential Equations	Linear homogeneous Complementary function Problems Non-homogeneous differential equations Solution by using the inverse differential operator method. Particular method for e^{ax} Particular method for sinax/ cosax Particular method for x^n
3	Week 5-6: Probability Theory	Introduction, Sample space and Events, Axioms of Probability. Addition and Multiplication theorem. Conditional Probability. Independent events. Baye's theorem, Problems.
4	Week 7-8: Numerical Methods -1	Solution of algebraic and transcendental equations - Regula-Falsi and Newton-Raphson methods, Problems. Finite differences, Interpolation using Newton's forward and backward difference formulae. Newton's divided difference formula Lagrange's interpolation formula. Problems. Numerical integration: Trapezoidal, Simpson's $(1/3)^{rd}$ and $(3/8)^{th}$ rules. Problems.
5	Week 9-10: Numerical Methods -2	Numerical solution of ordinary differential equations of first order and first degree - Taylor's series method. Problems Modified Euler's method Problems. Runge-Kutta method of fourth order. Problems. Milne's predictor-corrector formula. Problems.
6	Week 11-12: Integration and Practical Applications	Apply learned concepts and competencies to real-world scenarios. Hands-on practice

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of Verilog concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking (HOTS) Questions:	Pose HOTS questions to stimulate critical thinking related to each competency.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
6	Multiple	Introduce topics in various representations to reinforce competencies

	Representations	
7	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
8	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
9	Programming Assignments	Assign programming tasks to reinforce practical skills associated with competencies.

6. **Assessment Details (both CIE and SEE)**

Note:

- ✓ **Different types of courses will different assessment patterns, for which the applicable rules and regulations may be referred.**
- ✓ **An illustration for one of the course is given below.**

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). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and 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:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

7. Learning Objectives

S/L	Learning Objectives	Description
1.	Linear Algebra	Linear algebra is used to model and analyze dynamic systems, such as electrical circuits, mechanical systems, and chemical processes. Techniques like matrix operations, eigenvalues, and eigenvectors help engineers understand system behavior and design controllers for optimal performance.
2.	Higher-Order Differential Equations	Engineers use higher-order differential equations to model the motion of mechanical systems such as vibrating structures, rotating machinery, and vehicles, also used to describe the behavior of electrical circuits, including the flow of current and voltage across different components.
3.	Probability Theory	Probability theory in engineering is a mathematical framework used to model and analyze uncertainty in engineering systems. It provides tools for quantifying the likelihood of various outcomes and understanding the behavior of complex systems under uncertain conditions.
4.	Numerical Methods	Numerical integration methods, such as the trapezoidal rule, Simpson's rule are used to approximate definite integrals. Numerical differentiation methods, such as finite differences, are used to estimate derivatives.

8. Course Outcomes (COs) and Mapping with POs/ PSOs

Course Outcomes (COs)

COs	Description
M23BDIPM411.1	Apply elementary probability theory; solve related problems on consistency and system of linear equations.
M23BDIPM411.2	Apply numerical methods in modeling and the concept of higher order differential equations for solving engineering problems.
M23BDIPM411.3	Analyze the Engineering application problem through Numerical technique.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12
M23BDIPM411.1	**3**	**-**	-	-	-	-	-	-	-	-	-	-
M23BDIPM411.2	**3**	**-**	-	-	-	-	-	-	-	-	-	-
M23BDIPM411.3	**-**	**3**	-	-	-	-	-	-	-	-	-	-
M23BDIPM411	**3**	**3**	-	-	-	-	-	-	-	-	-	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	**Total**
Module 1	**10**			**10**
Module 2		**10**		**10**
Module 3			**10**	**10**
Module 4	**5**			**5**
Module 5			**5**	**5**
Total	**15**	**10**	**15**	**50**

10. Future with this Subject

The “Additional Mathematics-II "course in the second year of the B.E program has strong foundation for several future courses in the undergraduate program. The future for engineering students who study subjects like linear algebra, higher-order differential equations, probability theory, and numerical methods is promising and filled with opportunities. Here's why:

Industry Demand:

Industries across various sectors, including aerospace, automotive, electronics, and energy, rely heavily on mathematical modeling and analysis. Proficiency in subjects like linear algebra, differential equations, probability theory, and numerical methods is essential for solving complex engineering problems in these industries.

Advanced Technology and Innovation:

With the rapid advancement of technology, engineering solutions are becoming increasingly complex. Skills in mathematical modeling and computational techniques are crucial for developing innovative technologies and solutions. Knowledge of these mathematical subjects is not limited to a single engineering discipline but finds applications across various fields. Engineering students with a strong foundation in these subjects can explore interdisciplinary opportunities and collaborate on projects that require diverse skill sets.

Research and Development:

In research and development (R&D) roles, engineers often encounter complex mathematical problems that require advanced analytical and computational techniques. Proficiency in subjects like linear algebra, differential equations, and numerical methods is essential for conducting impactful research and developing innovative solutions.