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MAHARAJA INSTITUTE OF TECHNOLOGY MYSORE

Autonomous Institution Affiliated to VTU

Competency Based Syllabus (CBS)

for

Mechanical 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

Mechanical Engineering

2023 Scheme

Scheme Effective from the academic year 2023-24

Dean Academics
MIT Mysore

APPROVED
Dean Academics

Principal
MIT Mysore

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

3rd Semester	Basic Science Course (BS) MATHEMATICS-III FOR ME STREAM	M23BMATM301

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 with the goal of defining 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 identify the dependent and independent variables
5	Basic Concept of Permutation and Combination	Knowledge of basics 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	**Combinational Logic Circuits**	**Knowledge:** Understanding of Binomial, Exponential, 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	**Laplace transforms and its Applications**	**Knowledge**: Laplace Transforms, Periodic Function, Inverse Laplace Transforms **Skills**: Solving differential equations by the Laplace-transform method. **Attitudes:** Valuing the importance of Laplace transform and inverse Laplace transforms in solving the differential equations
4	**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
5.	**Numerical Solution of Partial Differential Equations**	**Knowledge**: Partial Differential Equations, Heat equation and Wave equation **Skills**: Solving ordinary and partial differential equations arising in engineering applications, using numerical methods **Attitudes:** Appreciation for using partial differential equation in heat and wave equation

3. Syllabus

Mathematics-III for CV Stream (M23BMATM301) SEMESTER – III			
Course Code	**M23BMATM301**	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

Module -1 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 Laplace Transform	
Definition and Properties of Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$ Laplace transforms of Periodic functions, and unit-step function (Statement Only) – problems. Inverse Laplace transforms definition and problems, Solution of differential equations.	**L1, L2, L3**
Module -4 : 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 -5 Numerical Solution of Partial Differential Equations	
Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank- Nicholson method, Solution of the Wave equation. Problems.	L1, L2,L3

Text Books:

1. **B.S.Grewal**:"HigherEngineeringMathematics",Khannapublishers,44thEd.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10thEd.(Reprint),20

Reference Books

1. **V.Ramana:** "HigherEngineeringMathematics" McGraw-HillEducation,11thEd.
2. **Srimanta Pal & Subodh C.Bhunia**: "Engineering Mathematics" OxfordUniversityPress,3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book

Co. Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education (India) Pvt. Ltd2015.
6. **H.K.Dass and Er.RajnishVerma:**"HigherEngineeringMathematics"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 (Write the proposed syllabus coverage in detail with maximum of 5 lines)
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: Laplace transforms and its Applications	Definition and Laplace transforms of elementary functions Problems on Laplace's Transform of $e^{at}f(t)$ Problems on Laplace's Transform of$t^n f(t)$ Problems on Laplace's Transform of (f(t))/t Laplace transforms of Periodic functions unit-step function-Problems Inverse Laplace transforms definition and problems Solution of differential equations
4	Week 7-8: Fourier Series	Introduction to trigonometric polynomial, trigonometric series. Dirichlet's conditions Fourier Series of periodic functions with period$2l$ Worked Problems Fourier Series of periodic functions with period2π Worked Problems Practical harmonic analysis. Worked Problems
5	Week 9-10: Numerical Solution of Partial Differential Equations	Classifications of second-order partial differential equations finite difference approximations to derivatives Solution of Laplace's equation using standard five-point formula Worked Problems Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method Worked Problems Solution of the Wave equation Worked 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 Mathermiatics concepts.
3	Collaborative	Encourage collaborative learning for improved competency application.

	Learning	
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)

Continuous Internal Evaluation:

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

CIE Split up

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 Examination:

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 Transforms and its Fundamentals	Students will learn Use Laplace transform and inverse Laplace transform 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 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, Statistical inference, series and transforms to solve Engineering Problems**
M23BMATM301.2	**Analyze the Mechanical Engineering application problems through Least squares, statistical, transforms, partial differential equation and series method**
M23BMATM301.3	**Relate the importance of transforms and partial differential equation appearing in Mechanical engineering**

CO-PO-PSO Mapping

COs/POs	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	CO4	CO5	**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	CO4	CO5	**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**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The "Mathematics-III for ME 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 mathematicians 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.

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	Basic Science Course (BSC) BIOLOGY FOR ENGINEERS	M23BBIOK301

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 Structure and 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 life processes.
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 life processes.
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-Bioinspired Materials and Mechanisms**	**Knowledge:** • Comprehend the principles behind bioinspired 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 behind bioengineering. **Skills:** • Analyze and apply knowledge of bioengineering principles to understand various environmental and industrial contexts. **Attitudes:** • Demonstrate curiosity about how natural systems work and their potential applications. • Exhibit a proactive approach to learning from nature to solve engineering challenges.

3. Syllabus

BIOLOGY FOR ENGINEERS SEMESTER – III/IV			
Course Code	M23BBIOK301	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 natural systems.
- 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 Bioplastics, 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 Perfluorocarbons (Pfcs).	L1, L2, L3
MODULE 5 (3 Hours)	
TRENDS IN BIOENGINEERING: Scaffolds In Muscular, Skeletal Systems and Tissue Engineering, Bioprinting Techniques and Materials. Electrical Tongue and Electrical Nose in Food Science, DNA Origami and Biocomputing, Bioimaging, and Artificial Intelligence for Disease Diagnosis. Bioconcrete. Bioremediation. Biomining.	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 GeethaA 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.

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 and their Applications	**Competency:** Apply knowledge of biomolecules to real-world applications **Knowledge:** Understand the properties and functions of key biomolecules: 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 as a 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-Bioinspired Materials and Mechanisms	**Competency:** Utilize bioinspired materials and mechanisms. **Knowledge:** Understand and explain natural bio-inspired mechanisms. **Skills:** Apply knowledge of natural principles to design innovative materials and systems.
5	Week 11-12: Trends in Bioengineering	**Competency:** Keep abreast of current trends and technologies in bioengineering. **Knowledge:** Understand the principles and applications of various bioengineering 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	**Collaborative Learning**	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 application of competencies
6	**Multiple**	Introduce topics in various representations to reinforce competencies

	Representations	
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)

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 application of 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	Bioinspired 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/ PSOs

Course Outcomes (COs)

COs	Description
M23BBIOK301.1	Elucidate the fundamentals of biological concepts employing pertinent health, and engineering applications.
M23BBIOK301.2	Assess the biological ideologies for the design and development of novel bioengineering solutions.
M23BBIOK301.3	Substantiate and apply the ideologies amid nature-inspired biomimetics perceptions for explicit engineering solutions.
M23BBIOK301.4	Exploring innovative biobased solutions for relevant biological complications.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M23BBIOK301.1	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
M23BBIOK301.2	**3**	**-**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**3**
M23BBIOK301.3	**3**	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
M23BBIOK301.4	**3**	**-**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**
M23BBIOK301	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Total					

Semester End Examination (SEE)

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

Conditions for SEE Paper Setting:

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

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 design personalized medical treatments.
   - Applications: Developing patient-specific drugs, gene therapy, and personalized treatment plans based on individual genetic profiles.
2. **Regenerative Medicine and Tissue Engineering:** Studying stem cells, scaffolding materials, and growth factors.
   - Applications: Creating artificial organs, repairing damaged tissues, and developing bioengineered skin for burn victims.
3. **Bioprinting:** Learning about 3D printing techniques and biomaterials.
   - Applications: Printing tissues and organs, developing complex tissue structures for research and therapeutic use.
4. **Synthetic Biology:** Engineering biological systems for new functions.
   Applications: Designing microorganisms to produce biofuels, clean pollutants, or synthesize pharmaceuticals.
5. **Biomedical Imaging and Diagnostics**: Understanding imaging technologies and diagnostic tools.
   - Applications: Advancing MRI, CT scans, and other imaging technologies to improve diagnostic accuracy and patient outcomes.
6. **Wearable Health Technologies:** Integrating biology with electronics and materials science.
   - Applications: Developing wearable devices that monitor health metrics, detect diseases early, and provide real-time health data to patients and doctors.
7. **Artificial Intelligence in Healthcare:** Combining biology with data science and machine learning.
   - Applications: Using AI to analyze complex biological data, predict disease outbreaks, and personalize medical treatments.
8. **Environmental Bioengineering:** Applying biological principles to environmental challenges.
   - Applications: Bioremediation, biomining, 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 solve medical problems.
2. **Clinical Research Scientist**:
   - Role: Conduct research to improve medical technologies and treatment methods.
   - Skills: Applying biological and engineering expertise to clinical trials and laboratory research.
3. **Biotech Product Manager**:
   - Role: Oversee the development and marketing of biotech products.

- Skills: Understanding both the technical aspects of bioengineering and the commercial landscape.

4. **Regenerative Medicine Specialist**:
   - Role: Focus on developing therapies that regenerate damaged tissues and organs.
   - Skills: Combining knowledge of cell biology, biomaterials, and clinical applications.
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 and develop 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 generation of engineers.

3rd Semester	Professional Course (PC) MECHANICS OF MATERIALS	M23BME302

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Science	• Basic knowledge of different materials and their behaviors under various conditions. • Fundamental concepts of force, motion, energy, and equilibrium. • Understanding forces, moments, and their effects on stationary and moving bodies.
2	Mathematics:	• Understanding of solving linear and quadratic equations • Proficiency in differential and integral calculus, including applications. • Familiarity with geometric shapes, angles, trigonometric functions, and their properties.
3	Engineering Mechanics:	• Grasp of mechanical principles such as Newton's laws, free-body diagrams, and vector operations. • Equilibrium of particles and rigid bodies, structural analysis (trusses, beams, frames). • Breaking down complex problems into simpler parts and analyzing each part systematically.
4	Material Science:	• Basic concepts of stress, strain, and material properties like elasticity and plasticity. • Understanding how materials respond to external loads, including elastic and plastic deformation. • Assess stress-strain relationships and material properties and Apply theoretical concepts to practical scenarios.
5	Structural Analysis:	• Evaluate material strengths and weaknesses, Use tools and methods for structural analysis. • Skill in evaluating the strengths and weaknesses of different materials and processes. • Ability to think critically and make connections between different concepts within materials science.
6	Thermal Stresses:	• Understanding how temperature changes can induce stress in materials. • Understand material properties related to thermal expansion and Apply principles to real-world scenarios. • Interest in the effects of thermal changes on materials for investigation of thermal stress phenomena
7	Theories of Failure	• Understanding material properties and behavior to fundamental principles of mechanics. • Familiarity with stress analysis techniques, including calculations of normal and shear stresses. • Interest in understanding underlying principles of failure theories and eagerness to explore real-world applications.

2. Competencies

S/L	Competency	KSA Description
1	**Stresses and Strain**	**Knowledge:** Definitions and derivations of stress and strain. Stress-strain diagrams, Poisson's ratio, elastic constants, and Hooke's Law. **Skills:** Deriving and applying stress-strain relationships. Solving problems on deformation, resilience, and thermal stresses. **Attitudes:**

		Attention to detail in calculations and diagrams. Persistence in analyzing complex load scenarios.
2	**Two-Dimensional Stress Analysis**	**Knowledge:** Concepts of plane stress, inclined section stresses, principal stresses, and maximum shear stresses. Mohr's circle for plane stress. **Skills:** Analytical skills for calculating stresses and using Mohr's circle. **Attitudes:** Attention to detail in stress analysis and calculations. Persistence in solving complex stress problems and verifying results
3	**Beams**	**Knowledge:** Definitions of beams, shear force, and bending moment, types of beams and load distributions. S.F. and B.M. diagrams, point of contra flexure, simple bending theory. Bending equation, neutral axis, bending stresses, and section modulus. **Skills:** Creating and interpreting S.F. and B.M. diagrams. Deriving and applying bending and shear stress formulas. Designing beam sections based on stress analysis. Analyzing stress distribution across different beam geometries. **Attitudes:** Attention to detail in diagram creation and stress calculations and persistence in solving complex bending and shear problems.
4	**Shafts and Columns**	**Knowledge:** Understanding of torsion, pure torsion, and torsional equations. Theory of columns, including long and short columns, Euler's formula, and Rankine's formula. **Skills:** Deriving and applying torsional equations. Analyzing power transmission in shafts. Solving problems related to column stability and strength. **Attitudes:** Attention to detail in torsional and column analysis and explore the behavior of shafts and columns under different conditions.
5	**Theories of Failure and Cylinders**	**Knowledge:** Understanding of Maximum Principal Stress Theory and Maximum Shear Stress Theory. Knowledge of stress analysis and failure criteria. Awareness of factors influencing failure in materials. Stresses in thin and thick cylinders, including Lame's equation and dimensional changes **Skills:** Assessing the suitability of failure theories for different materials and loading conditions. Technical proficiency in applying Lame's equation and solving numerical problems. **Attitudes:** Attention to detail in stress analysis and failure prediction. Curiosity to understand the underlying principles of failure theories.

3. Syllabus

MECHANICS OF MATERIALS SEMESTER – III			
Course Code	**M23BME302**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(2:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**50 hours Theory**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**
Course Objectives: **1.** To, learn what stress and strain are and how materials behave under pressure.			

2. To analyzing structures figure out how different structures respond to different types of forces. **3.** To Calculating Forces and learn how to calculate the forces and moments acting on beams, shafts, and columns. **4.** Testing Materials to understand how materials respond to stress and when they might break. **5.** Designing Structures: Use stress analysis to design strong and safe structures. **6.** Get familiar with computer programs that help with stress analysis and design.
Module -1
Simple stress and strain: Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, Calculation of stresses in straight, Stepped and tapered sections, **Composite sections**, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.
Module -2
Analysis of Stress and Strain: Introduction to three dimensional state of stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions.
Module -3
Shear Force and Bending Moment: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads, uniformly distributed constant / varying loads. **Stress in Beams:** Assumptions Derivation of bending equation Neutral axis Determination of bending stresses section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections Design of simple beam sections.
Module -4
Torsion: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts **Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, and Secant formula for columns.
Module -5
Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, And Thick cylinders: Lames equations.
TEXTBOOKS: 1. James M Gere, Barry J Goodno, Strength of Materials, Indian Edition, Cengage Learning, 2009. 2. R Subramanian, Strength of Materials, Oxford, 2005. **REFERENCE BOOKS:** 1. S S Rattan, Strength of Materials, Second Edition, McGraw Hill, 2011. 2. Ferdinand Beer and Russell Johston, Mechanics of materials, Tata McGraw Hill, 2003. **VIDEO LINKS:** 1. https://onlinecourses.nptel.ac.in/noc22_ce54/preview 2. https://mitlibraryblog.wordpress.com/mitm-videos/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-3: Simple Stress and Strain	Introduction to concepts of stress and strain subjected to tensile, compression and shear load for different cross-sections. Studying the effect of changes in temperature on the bars when used in different applications.
2	Week 4-6: Analysis of stresses	Understanding the concepts of two-dimensional stress analysis and deducing the expression for plane stress and plane strain condition with and without shear by analytical and graphical methods.
3	Week 8-11: Shear force and Bending Moment Diagrams	Studying the different types of beams based on type of support and type of load. Determining the Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to point load, UDL and UVL. Analyzing the beams and studying the bending stresses on different machine components.
4	Week 7-8:	Introduction to the concepts of power transmission elements like shafts and designing

	Torsion and Columns	the shafts based on angle of twist and shear stress condition. Understanding the concepts of short and long columns with different boundary conditions and loads.
5	Week 9-12: Theories of failure and Cylinders	Introduction to theories of failure of applicable to various machine components with Maximum Principal stress theory, Maximum shear stress theory. Design and analysis of thick and thin cylinders.

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 Mechanics concepts.
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.
5	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
6	Laboratory Learning	Utilize the facilities available in the laboratories to understand the behavior of the materials by performing few experiments.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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

CIE Split up

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 Examination:

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	Stress and Strain	Grasp the basic principles of stress and strain, material properties, Hooke's law, and stress-strain behavior for different materials, enhancing foundational knowledge for mechanical engineering applications.
2	Elastic Constants and Thermal Stresses	Utilize elastic constants and relationships between them to solve engineering problems. Calculate stresses due to temperature changes, including thermal expansion and contraction effects, integrating knowledge for practical engineering applications.
3	Analysis of Stress and Strain	Analyze three-dimensional stress states, calculate principal stresses, shear stresses on inclined planes, and utilize Mohr's circle for plane stress conditions, developing analytical skills for complex stress scenarios.

4	Beam Analysis and Design	Evaluate shear forces and bending moments in various beam types under different loading conditions. Derive and apply the bending equation, determine section modulus, and design simple beam sections, promoting practical structural analysis and design capabilities.
5	Torsion and Columns	Understand torsional behavior of shafts, derive torsional equations, and calculate torsional rigidity. Analyze buckling and stability of columns, determines critical loads, and apply the Secant formula for columns, preparing for real-world mechanical design challenges.
6	Theories of Failures and Cylinders	Apply maximum principal stress and maximum shear stress theories to predict material failure. Analyze stresses and strains in thin and thick cylinders using Hoop's stress and Lame's equations, ensuring a comprehensive understanding of pressure vessel design.

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

Course Outcomes (COs)

COs	Description
M23BME302.1	**Understand and Apply** fundamental concepts of stress, strain, material properties, and Hooke's law
M23BME302.2	**Analyze** three-dimensional stress states, principal stresses, maximum shear stresses, and use Mohr's circle for plane stress conditions.
M23BME302.3	**Evaluate** shear forces and bending moments in various beam types under different loads, and **apply** the bending equation.
M23BME302.4	**Calculate** torsional equations, polar modulus, torsional rigidity, and analyze column buckling and stability.
M23BME302.5	**Implement** maximum principal stress and maximum shear stress theories, and **analyze** thin and thick cylinder stresses.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME302.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME302.2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME302.3	-	-	3	3	-	-	-	-	-	-	-	-	3	-
M23BME302.4	-	-	-	3	-	-	-	-	-	-	-	-	-	3
M23BME302.5	**-**	**-**	3	-	-	-	-	-	-	-	-	-	3	3
M23BME302	**3**	**3**	3	3	-	-	-	-	-	-	-	-	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:

- **Integration of Advanced Computational Tools**: The curriculum will likely incorporate the use of advanced computational tools and software for stress and strain analysis, enhancing students' proficiency in simulation-based design and analysis.
- **Focus on Sustainable Materials and Design**: With a growing emphasis on sustainability, the curriculum may evolve to include modules on the use of eco-friendly materials and sustainable design practices to minimize environmental impact while ensuring structural integrity.
- **Interdisciplinary Applications**: There may be a shift towards interdisciplinary applications, where concepts of stress and strain are integrated with other engineering disciplines such as biomechanics, aerospace engineering, and materials science to address complex real-world challenges.
- **Emphasis on Industry-Relevant Skills**: The curriculum will likely place greater emphasis on developing industry-relevant skills such as project management, teamwork, and communication, preparing students for diverse roles in engineering firms and research institutions.
- **Adaptation to Technological Advancements**: As new materials and manufacturing techniques emerge, the curriculum will need to adapt to incorporate these advancements, ensuring graduates are equipped with the latest knowledge and skills to stay competitive in the rapidly evolving field of engineering.

3rd Semester	Professional Course (PC) METAL CASTING AND FORMING	M23BME303

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Engineering drawing**	Ability to read & interpret Geometrical Shape & Size which is crucial for visualizing mold & die designs.
2	**Materials and Equipment**	Knowledge on various types of materials used for preparation of pattern, mold & core boxes, in both Sand & Metal casting Process.
3	**Melting temperature & Equipment's**	Knowledge on type of Furnace or crucible capable of reaching the required temperature to melt the chosen metal in both ferrous & Non-ferrous foundries.
4	**Understand the principles of melting furnace**	Knowledge of safety procedures for working with electricity, molten metal and understanding of charging practices into the furnace.
5	**Familiarity with defects**	Ability to Recognize & determine root cause of common defects occurs in manufacturing process and about parameters can influence these defects
6	**Metalworking Tools**	Familiarity with construction & working of common tools like hammers, chisels, files, saws, wrenches, clamps on cutting & Bending for interpreting according final shape or designs
7	**Properties of metals related to forming**	Knowing different metal types, their properties like strength, ductility, and how they react to various forming processes.

2. Competencies

S/L	Competency	KSA Description
1	**Fundamentals of foundry process**	**Knowledge** • Understanding of various casting methods (sand casting, investment casting, die casting etc. • Awareness of different mold and core making techniques, • Knowledge of solidification principles and how they can affect casting quality **Skills** • Ability to operate various foundry equipment safely and efficiently (furnaces, molding machines, etc.) • Proficiency in molten metal handling techniques. **Attitude** • Attention to detail and prioritizing safety during all casting operations. • learn and adapt to new casting techniques and technologies
2	**Basic Materials used in Foundry**	**Knowledge** • Properties of common casting alloys (cast iron, steel, aluminum etc.) • Molding materials and their selection (sand, plaster, ceramic etc.) • Gating system design principles. • Solidification behavior of metals and solidification defects **Skills** • Select appropriate casting processes based on part complexity, material, and production volume **Attitude** • Problem-solving skills to identify and troubleshoot casting defects • Safety consciousness when working with molten metal
3	**Melting furnaces**	**Knowledge** • Able to understand Different types of melting furnaces, functionalities, and their process parameters. • factors affecting metal melting (e.g., metal type, temperature control, furnace lining)

		• Safety procedures for furnace operation and metal handling **Skill** • Ability to identify the appropriate furnace for a specific metal and casting process. • Able to operate the furnace safely, following proper procedures for charging, melting, and pouring **Attitude** • Adherence to safety protocols and procedures Attentive to details during furnace operation to ensure proper metal quality.
4	**Principles of solidification**	**Knowledge** • Able to understand Different solidification mechanisms. • Factors affecting solidification rate (cooling rate, mold material) • Microstructure development during solidification **Skill** • Able to select appropriate mold materials based on solidification requirements. • Able to Design gating systems to promote directional solidification **Attitude** • Commitment to producing Defect free castings and to maintain quality control of the finished product.
5	**Fundamentals of forming**	**Knowledge** • Understanding of material properties and behavior at forming temperatures, such as strength, ductility, and work hardening. • Awareness of the effects of forming processes on the microstructure and mechanical properties of metals. **Skill** • Ability to operate forming machines safely and efficiently and to inspect formed parts for quality. • Ability to set up and operate rolling mills and troubleshoot rolling problems (surface defects, dimensional errors). • Skill in designing tooling (e.g., dies, rolls) for forming operations, ensuring proper material flow and dimensional accuracy. **Attitude** • Attention to detail and quality, focusing on precise control of process parameters to achieve desired product specifications. • Adherence to safety protocols and procedures - Attention to detail and quality control without any defects
6	**Concepts of sheet metal forming**	**Knowledge** • Be familiar with common sheet metal forming processes (shearing, bending, punching, forming) and their applications. • Understand the principles of sheet metal layout and development, including bend allowances and pattern creation. **Skill** • Able to Perform cutting, bending, punching, and forming operations on sheet metal with accuracy and precision. • Able to Use appropriate measuring tools and techniques to ensure accuracy during sheet metal fabrication. **Attitude** • Able to Approach challenges and identify solutions for issues encountered during sheet metal work.

3. Syllabus

Metal Casting & Forming **SEMESTER – III**			
Course Code	**M23BME303**	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 objective:

- Provide a comprehensive understanding of the principles and practices of metal casting and forming processes.
- Ability to analyze and select the most suitable metal casting and forming process for a given application
- Identify and classify different types of melting furnaces based on their operating principles and fuel sources.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys
- To acquaint with the basic knowledge on fundamentals of metal forming processes

Module -1

Introduction & basic materials used in foundry: Introduction: Definition, Classification of manufacturing processes. Classification of foundry on Metals cast, Introduction to casting process & steps involved.

Patterns: Definition, classification, Types of pattern, materials used for pattern, various pattern allowances and their importance.

Sand moulding: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; Types of Moulding machines- Jolt type, squeeze type and Sand slinger.

Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO_2mould, shell mould, investment mould.

Cores: Definition, need, types.

Concept of Gating (top, bottom, parting line, horn gate).

R**isers** (open, blind) Functions and it's types.

Module -2

Casting using metal moulds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Module -3

Solidification &non-ferrous foundry practice

Solidification: Definition, nucleation, solidification variables. Directional solidification-need and methods. Degasification in liquid metals-sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminium castings - advantages, limitations, melting of Aluminium using lift- out type crucible furnace., gas absorption, Stir casting set up, procedure, uses, advantages and limitations.

Module -4

Introduction to metal forming processes: Classification of metal forming processes. Hot working & cold working of metals.

Forging: Smith forging, drop forging & press forging. Defects in forging.

Drawing & Extrusion: Drawing of wires, rods & Tubes. Various types of extrusion processes. Defects in Extrusion. Difference between drawing & extrusion. Simple numericals

Module -5

Sheet Metal Operations: Blanking, piercing, punching, drawing, draw ratio, drawing force, variables in drawing, Trimming, and Shearing.

Bending — types of bending dies, bending force calculation, Embossing and coining.

Types of dies: Progressive, compound and combination die. Simple numericals

Text Books:

1. **"**Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 5 th Revised Edition 2009.

2. "Manufacturing & Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – 'Welding and Welding Technology' – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
4. Grong O. – 'Metallurgical Modelling of Welding' – The Institute of Materials – 1997 – 2nd Edition
5. Kou S. – 'Welding Metallurgy' – John Wiley Publications, New York – 2003 – 2nd Edition.
6. Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' – Prentice Hall – 2013 – 7th Edition
7. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
8. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.

Web links and Video Lectures (e-Resources):

1. Link:http://www.springer.com/us/book/9781447151784http://nptel.ac.in/courses/112 105127/
2. http://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL11.htm
3. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/COMPTECH/PAGES/CTR10654J.htm
4. MOOCs: http://nptel.ac.in/courses/112105126/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week1-2	• **Introduction & basic materials used in foundry**: Classification of foundry, Introduction to casting process & steps involved. • Types of pattern, materials used for pattern, pattern allowances. • Sand Moulding, Binder, Additive's and Moulding machines • Sand Moulding process, concepts of cores & It's Types.
2	Week 3-4:	• Concept of Gating and Risering System. • **Casting using Metallic molds**: Gravity die casting, pressure die casting, • squeeze casting, slush casting and , and continuous casting processes
3	Week 5-6	• **Melting furnaces:** Classification of furnaces gas fired pit furnace • **Resistance and Induction furnace and Cupola Furnace** • **Solidification &non-ferrous foundry practice**: Directional solidification-need and methods, degasification methods • **Fettling and cleaning of castings:** Sand Casting defects- causes, features and remedies. • Advantages & limitations of casting process.
4	Week 7-8	• **Nonferrous foundry practice:** Aluminum castings using lift out type of crucible furnace. • Drowsing, gas absorption, fluxing and flushing, Stir casting • **Introduction to metal forming processes**: Classification of metal forming processes. Hot working & cold working of metals. • **Forging**: Types of Forging & forging defects.
5	Week 9-10:	• **Drawing & Extrusion:** Drawing of wires, rods & Tubes. \ • Various types of extrusion processes. • Defects in Extrusion. • Difference between drawing & extrusion. • Simple Numerical
6	Week 11-12	**Sheet Metal Operations:** Blanking, piercing, punching, drawing, • Drawing ratio, drawing force, variables in drawing, • **Bending** — types of bending dies, , Embossing and coining. • Bending force calculation • **Types of dies:** Progressive, compound and combination die.

		• Simple numerical

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Lecture & Discussion**	Utilize various teaching methods within the lecture format to reinforce competencies.
2	**Power point Presentation**	Able to capture the attention of a student with a slide showcasing iconic metal products (e.g., car engines, bridges, airplane wings) and briefly discuss the importance of metal shaping in modern engineering.
3	**Video/Animation**	Utilize videos, animations, to illustrate casting processes and metal behavior during solidification. Showcase images and diagrams of different mold types, gating systems, and casting defects
4	**Hands-on Activities**	Setup labs for students to practice pattern making, sand mold preparation, and pouring techniques and Conduct demonstrations of melting furnaces, pouring equipment, and casting processes
5	**Guest Lectures**	Invite experts from metal casting foundries to share industry practices and challenges
6	**Industry Visits**	Organize field trips to casting facilities for students to observe real-world operations and equipment
7	**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)

Continuous Internal Evaluation:

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)	3	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 Examination

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 of fundamentals of Casting Process**	• Students will gain knowledge on various casting process in manufacturing. • Various molding techniques & procedure for handling molding tools. • Fundamentals concepts on Gating & Risering to obtain defect free casting.
2	**Understanding the concepts of Melting furnace & Metallic mold**	• Students will be able to describe different types of melting furnaces (e.g., arc furnace, induction furnace). • Explain the basic principles of how each furnace type melts metal and process parameters. • Basic principles involved in Metallic moulding techniques.
3	**Understanding the concepts Solidification &**	• Students will be able to explain the basic principles of solidification in casting processes, including the concepts of nucleation, crystal growth, and solidification sequence.

	Non-ferrous foundry Practices in Casting process	• Identify and describe different Solidification defects such as shrinkage porosity, hot tears, and segregation, and explain their causes and prevention methods. • Describe the characteristics and properties of common non-ferrous metals and alloys used in casting processes
4	**Understand parameters of metal working process to calculate load.**	• Students will able to explain the various forming process & their principles in manufacturing like forging, drawing, extrusion & Rolling, their process parameters. • Able to calculate the forming loads in bending & drawing process also angle of bite in rolling process.
5	**Concepts Sheet metal process**	• Students will be able to perform various bending & cutting operations using hand tools and machines. • Apply bending calculations to determine bending load.

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

Course Outcomes (COs)

COs	Description
M23BME303.1	Make use the fundamentals of casting process to describe the preparation of various sand moulding techniques & types of molding machines**.**
M23BME303.2	Interpret the selection of various melting furnace to describe their construction & working
M23BME303.3	Apply the concept of solidification process to describe solidification variables, methods of degassing in both ferrous & non-ferrous foundries.
M23BME303.4	Utilize the fundamental knowledge of metal working process to select appropriate methods & related parameters for obtaining finished from the raw material.
M23BME303.5	Analyze & calculate the forming loads in bending, drawing process.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME303.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME303.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME303.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME303.4	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME303.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME303	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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

a) **Smart Foundries:** Foundries will become intelligent hubs, where sensors and data analytics will be used to monitor and optimize every stage of the casting process. This real-time data will enable predictive maintenance, ensure consistent quality control, and minimize waste.

b) **Light weighting:** The use of advanced materials and innovative casting techniques will lead to the production of lighter, stronger metal components. This will be crucial for industries like aerospace and automotive, where weight reduction is a key factor in improving fuel efficiency.

c) **Additive Manufacturing Integration:** 3D printing will play a growing role in metal casting. It will be used to create complex molds and cores, eliminating the need for traditional tooling and reducing lead times. Additionally, 3D printing may even be used to directly print metal parts for low-volume applications.

d) **Digital Transformation:** The rise of computer-aided design (CAD) and simulation software will revolutionize casting processes. Virtual simulations will allow designers to predict metal flow, optimize mold design, and minimize casting defects before production even begins. This will lead to faster turnaround times, reduced waste, and improved product quality.

e) **Advanced Materials:** New-age materials like high-strength steel alloys and composites will push the boundaries of what's achievable with forging. These materials will allow for the creation of lighter, yet stronger components for applications in aerospace and automotive industries.

f) **Additive-Assisted Drawing/Extrusion:** Similar to rolling, drawing and extrusion processes could benefit from the marriage of additive manufacturing. 3D-printed mandrels could be used to create complex shapes within drawn or extruded tubes and profiles.

g) **Sustainability:** The metal forming industry will strive to become more environmentally conscious. This will involve using recycled materials, developing energy-efficient processes, and minimizing waste generation.

3rd Semester	Integrated Professional Course (IPC) MATERIAL SCIENCE AND ENGINEERING	M23BME304

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Science	• Understanding of atomic structure, electron configurations, and periodic table trends, basic chemical bonding concepts. • Knowledge of fundamental physics concepts, such as force, energy, and thermodynamics. • Understanding of wave properties, particularly as they relate to Bragg's Law and crystallography.
2	Introductory Materials Science:	• Knowledge of basic concepts of materials science, including types and classifications of materials. • Understanding of simple material properties such as hardness, ductility, and tensile strength.
3	Critical Thinking:	• Skill in evaluating the strengths and weaknesses of different materials and processes. • Ability to think critically and make connections between different concepts within materials science.
4	Application of Concepts	• Ability to apply theoretical knowledge to practical problems, such as identifying suitable materials for specific applications.
5	Laboratory Skills	• Familiarity with basic laboratory equipment and techniques. • Experience in conducting experiments, recording data, and following safety protocols. • Skill in presenting data and findings clearly and concisely, using appropriate scientific terminology. • Ability to effectively communicate scientific information, both orally and in writing.
6	Analytical Skills:	• Ability to analyze and interpret data, especially related to material properties and phase diagrams.

2. Competencies (A minimum of four competencies may be written)

S/L	Competency	KSA Description
1	**Material Structures**	**Knowledge:** Recognize different crystal structures, including cubic and hexagonal close-packed structures. Understand the concepts of coordination number, atomic packing factor, and planar atomic density. **Skills:** Analyze and interpret crystal structures using diagrams and models. Identify and label different planes and directions in a crystal lattice. **Attitudes:** Exhibiting meticulous attention when studying and analyzing crystal structures. Ensure precision in calculations and interpretations related to coordination numbers, APF, and planar atomic density.
2	**Defects in Solids:**	**Knowledge:** Identify and describe various types of imperfections in solids, such as point defects, line defects, and surface defects. Understand the concept of free volume in amorphous solids and its implications. **Skills:** Accurately identify and classify different types of imperfections in solids Use diagrams and models to visualize and distinguish between various types of

		defects **Attitudes:** Demonstrate a strong interest in understanding the role of defects in material properties and behavior. Show enthusiasm for exploring new methods and technologies for studying defects in solids.
3	**Phase Diagrams and Reactions:**	**Knowledge:** Interpret phase diagrams, including isomorphous systems and invariant binary reactions Apply Gibbs Phase Rule and understand solubility limits and phase equilibrium. **Skills:** Accurately read and interpret phase diagrams, identifying key features such as phase boundaries, invariant points, and phase regions. Analyze isomorphous systems and invariant binary reactions to understand the transformation processes and predict material behaviors. **Attitudes:** Demonstrate a keen interest in exploring the intricacies of phase diagrams and the reactions they represent, continuously seeking to expand knowledge in this area. Stay updated with the latest research and developments in materials science, particularly in the study of phase transformations and equilibrium.
4	**Heat Treatment and Strengthening Mechanisms**	**Knowledge:** Know various heat treatment processes (annealing, normalizing, hardening, tempering, etc.) and their effects on material properties. Understand the principles of TTT diagrams, recovery, recrystallization, and grain growth **Skills:** Develop a deep understanding of various heat treatment processes such as annealing, normalizing, hardening, and tempering. Learn the procedures, equipment, and parameters involved in each process. **Attitudes:** Apply critical thinking to analyze the outcomes of heat treatment processes, identifying the root causes of any discrepancies between expected and actual results.
5	**Engineering Materials and Their Properties**	**Knowledge:** Classify ferrous and non-ferrous materials and understand their properties, compositions, and uses. Understand the principles and applications of composite materials, including different matrix materials and reinforcements. **Skills:** Develop the ability to classify materials into ferrous and non-ferrous categories. Understand the criteria for classification and recognize examples of each type. Identify the key properties of various engineering materials, such as strength, hardness, ductility, conductivity, and corrosion resistance. Learn to link these properties to material composition and structure. **Attitudes:** Show a strong interest in exploring and understanding a wide range of engineering materials. Stay curious about new developments and innovations in material science.
6	**Laboratory**	**Knowledge:** Understand specimen preparation techniques for macro and microstructural analysis, principles of heat treatment, and methods for hardness, tensile, wear, and impact testing.

		Skills: Familiarity with using appropriate testing equipment and interpreting results to assess material properties **Attitudes:** Attitudes include meticulous attention to detail, prioritizing safety, curiosity for continuous learning, critical thinking for problem-solving, and upholding professionalism and integrity in laboratory work.

3. Syllabus

MATERIAL SCIENCE AND ENGINEERING SEMESTER – III			
Course Code	**M23BME304**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory + 8-10 Lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Course Objectives

1. Explain the basic concepts of geometrical crystallography, crystal structure and imperfections in
2. Solids.
3. Construct the phase diagrams to know the phase transformations and concept of diffusion in solids.
4. Identify the heat treatment, cooling method for controlling the microstructure and plastic deformation to modify their properties.
5. Apply the method of materials selection, material data, properties and knowledge sources for computer-aided selection of materials.

Module -1

Structure of Materials

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding.

Crystal Structure: Crystal Lattice, Unit Cell, Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexagonal Close Packed structure.

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects. Plastic deformation of single crystal by slip and twinning

Module -2

Mechanical Behaviour: Stress-strain diagrams showing ductile and brittle behaviour of materials, Engineering stress and true strains, Linear and non- linear elastic behaviour Mechanical properties in plastic range and elastic range.

Failure of Materials Fracture: Type I, Type II and Type III, **Fatigue:** Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, S-N diagram, fatigue testing.

Creep: Description of the phenomenon, stages of creep, creep properties.

Module -3

Diffusion: Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion.

Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules of solidification, mechanism of solidification, homogeneous and heterogeneous nucleation.

Phase Diagrams: Definition, objectives, cooling curves, construction of phase diagram and its interpretation , Gibbs Phase rule, types of Phase diagram-Solid solution, Eutectic .Eutectoid

Module -4

Heat treatment: TTT diagram, Recovery-Recrystallization Strengthening mechanisms: Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.

Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology

Module -5

Engineering Materials and Their Properties: Classification, **Ferrous materials:** Properties, Compositions and uses of Grey cast iron and steel. **Non-Ferrous materials:** Properties, Compositions and uses of Copper, Brass, Bronze.

Composite materials - Definition, classification based on reinforcement and matrix types, Advantages, limitations and Applications of composite materials, fabrication of composite materials using hand layup process, stir casting and injection molding

	PRACTICAL COMPONENT
1	Specimen preparation for macro and micro structural examinations and study the Macrostructure and microstructure of a sample metal/ alloys.
2	To determine the hardness values of Mild Steel by Rockwell hardness/Vickers Hardness.
3	To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine.
4	To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminum and to observe the necking.
5	To conduct a wear test on Mild steel/ Cast Iron/Aluminum/Copper to find the volumetric wear rate and coefficient of friction.
6	To determine the Impact strength of the mild steel using Izod test and Charpy test.
7	Study the chemical corrosion and its protection. ***Demonstration***
8	Study the properties of various types of plastics. ***Demonstration***

Text Books:

1. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An Introduction, 10th Edition, Hoboken, NJ: Wiley.
2. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth- Heinemann.
3. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.

Reference Books

1. Jones, D.R.H., and Ashby,M.F., (2011), Engineering Materials 1: An Introduction to Properties,
2. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi,2008.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2 **Structure of Materials**	Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding. Crystal Lattice, Unit Cell, Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexagonal Close Packed structure. Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects. Plastic deformation of single crystal by slip and twinning
2	Week 3-4 **Mechanical Behaviour**	Stress-strain diagrams showing ductile and brittle behaviour of materials, Engineering stress and true strains, Linear and non- linear elastic behaviour Mechanical properties in plastic range and elastic range . Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, S-N diagram, fatigue testing.Description of the phenomenon stages of creep, creep properties.
3	Week 5-6: **Diffusion**	Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion. Classification of Solid solutions, Hume- Rothery Rules of solidification, mechanism of solidification, homogeneous and heterogeneous nucleation. cooling curves,
4	Week 7-8: Phase Diagram	Construction of phase diagram and its interpretation , Gibbs Phase rule, types of Phase diagram-Solid solution, Eutectic .Eutectoid TTT diagram, Recovery-Recrystallization Strengthening mechanisms:

		Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.
5	Week 9-10: Heat Treatment	Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology
6	Week 11-12 Engineering Materials	Classification, Properties, Compositions and uses of Grey cast iron and steel. Properties Compositions and uses of Copper, Brass, Bronze. - Definition, classification based on reinforcement and matrix types, Advantages, limitations and Applications of composite materials, fabrication of composite materials using hand layup process, stir casting and injection molding

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 materials engineering concepts.
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.
5	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)

Theory Course with 4 credits: 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 Examination pattern:

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. 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	Crystal structure and imperfections in Solids.	Students will understand the concept of different metal structures , types of imperfections present in the structure

2	Mechanical Behavior and failure	Students will learn how the metal behaves on loading and study of different properties of metals from stress-strain curve and different types of material failures
3	Phase diagrams and Heat treatment	Students understand the importance of phase diagram, its construction and interpretation also how properties of materials can be changed by different heat treatment process
4	Engineering Materials	Students learn the classification of engineering materials its composition ,properties and applications
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.
7	Ethical and Professional Responsibility	Students will understand the ethical and professional responsibilities associated learning skills understand the concepts and evaluate the results.

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

Course Outcomes (COs)

COs	Description
M23BME304.1	**Apply** the acquired knowledge of crystalline solids to infer the atomic arrangements and imperfections in various solids
M23BME304.2	**Identify** the behavior of materials under elastic and plastic deformations and through various types of loading
M23BME304.3	**Interpret** the alloy systems and analyse phase diagram
M23BME304.4	**Analyze** various heat treatments process based on properties
M23BME304.5	**Outline** various compositions of engineering materials to exhibit their properties and **interpret** processing of composite materials
M23BME304.6	**Demonstrate** the mechanical properties of various engineering materials

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME304.1	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME304.2	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME304.3	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-
M23BME304.4	-	**3**	-	-	-	-	-	-	-	-	-	-	-	-
M23BME304.5	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME304.6	**3**	-	-	-	-	-	-	-	-	-	-	-	**2**	-
M23BME304	**3**	**3**	-	-	-	-	-	-	-	-	-	-	**2.5**	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	CO6	**Total**
Module 1	**08**					**02**	**10**
Module 2		**08**				**02**	**10**
Module 3			**08**			**02**	**10**
Module 4				**08**		**02**	**10**
Module 5					**08**	**02**	**10**
Total	**08**	**08**	**08**	**08**	**08**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	CO6	Total
Module 1	**16**					**04**	**20**
Module 2		**16**				**04**	**20**
Module 3			**16**			**04**	**20**
Module 4				**16**		**04**	**20**
Module 5					**16**	**04**	**20**
Total	**16**	**16**	**16**	**16**	**16**	**20**	**100**

10. Future with this Subject

The "Material Science and Engineering" course in the third semester of the B.E Mechanical 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 manufacturing and materials engineering. Here are some notable contributions:

Technological Advancements

The course of material science and engineering is intrinsically linked to technological advancements. Innovations in material processing are leading to the development of materials with unprecedented properties, such as enhanced strength and electrical conductivity at the atomic level. This is particularly impactful in any discipline of engineering or technology that revolutionizes manufacturing processes by enabling the creation of complex structures with tailored properties, from metal components to aerospace components to customized medical implants.

Educational and Research Opportunities

The growing importance of material science and engineering is reflected in expanding educational programs and research opportunities. Universities and research institutions are increasingly offering specialized degrees and investing in cutting-edge laboratories. This trend is preparing a new generation of scientists and engineers equipped with the skills necessary to tackle future challenges and drive continued innovation in this dynamic field.

Aerospace and Automotive Industries

The aerospace and automotive industries are constantly seeking materials that offer a balance of lightweight properties and high strength. Material scientists are developing advanced composites and alloys that improve fuel efficiency and performance while reducing emissions. The future scope includes the potential for self-healing materials that can repair minor damages autonomously, increasing the longevity and safety of vehicles and aircraft.

3rd Semester	Professional Course (PC) BASIC THERMODYNAMICS	M23BME305

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Understanding of Physical Quantities and Units	Students should be comfortable with concepts like mass, length, time, temperature, pressure, and be able to work with different unit systems (SI units are preferred).
2.	Mathematical Problem Solving	Familiarity with differentiation and integration will be advantageous. Calculus helps understand how properties change with respect to other variables.
3.	Problem-Solving Skills	The ability to use learned concepts and equations to solve numerical problems by applying their knowledge to various scenarios.
4.	Physics Fundamentals	Students need a strong grasp of Newtonian mechanics, including the concepts of force, motion, and energy. They should understand the principles of work and energy, as well as power and efficiency. A basic understanding of heat transfer, temperature scales, and the properties of matter is an added advantage.
5.	Chemistry Fundamentals	Students should be familiar with the basic structure of atoms, molecules, and ions. They must understand chemical reactions, including stoichiometry and conservation of mass. Knowledge of the ideal gas law and other gas laws, as well as phase changes and basic thermodynamic quantities such as enthalpy and entropy, is an added advantage.

2. Competencies

S/L	Competency	KSA Description
1.	**Zeroth law of thermodynamics**	**Knowledge:** Thermodynamic Properties, Thermal Equilibrium and Temperature Measurement, Work vs. Heat **Skills:** Unit conversion, temperature scale conversion, problem solving using work and heat equation. **Attitudes:** Appreciation for the importance of various temperature scales and temperature measuring devices
2.	**First law of thermodynamics**	**Knowledge:** Energy transfer in closed and open system, control volume **Skills:** Energy and mass balance, work and heat calculation using first law **Attitudes:** Appreciation for importance of energy balance.
3.	**Second law of thermodynamics**	**Knowledge:** Clausius and Kelvin-Planck Statements, Carnot Principle and Carnot Cycle, reversible and irreversible processes, entropy **Skills:** Application of second law to heat engines, refrigerators and heat pumps **Attitudes:** Appreciation for importance of efficiency in engineering design.
4.	**Pure substance**	**Knowledge:** Phase Equilibrium, P-T and P-V diagrams, T-S and H-S diagrams **Skills:** Interpreting thermodynamic data from tables and charts for pure substances

		Attitudes: Appreciate the significance of the existing data during phase change process to real world applications
5.	**Ideal and Real gases**	**Knowledge:** Relationships between pressure, volume, temperature, limitations of the ideal gas law and real gas **Skills:** calculations of gas properties using ideal and real gas equations **Attitudes:** Appreciating the simplicity of the ideal gas equation while recognizing its limitations in describing real-world gas behavior.

3. Syllabus

BASIC THERMODYNAMICS **SEMESTER – III**			
Course Code	M23BME305	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	Total Marks	**100**
Credits	03	Exam Hours	**03**

Course objectives: This course will enable students to:

- Learn about thermodynamic systems and boundaries and Identify various types of properties (e.g., extensive and intensive properties)
- Understand various forms of energy including heat transfer and work
- Study the basic laws of thermodynamics including, conservation of mass, and conservation of energy or first law, second law and Zeroth law of thermodynamics.
- Apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers, etc.)
- Use tables, equations, and charts, in evaluation of thermodynamic properties

Module -1	
Introduction and Review of fundamental concepts: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium **Zeroth law of thermodynamics,** Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical. **Work and Heat:** Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems.	L1, L2, L3
Module -2	
First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems. **Extension of the First law to control volume;** steady flow energy equation (SFEE), Problems.	L1, L2, L3
Module -3	
Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems	L1, L2, L3

Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems	
Module -4	
Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Problems.	L1, L2, L3
Module -5	
Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. **Real gases** – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.	L1, L2, L3

Text Books:

1. **Basic and Applied Thermodynamics P.K.Nag, Tata McGraw Hill 2nd Ed., 2002.**
2. **Basic Engineering Thermodynamics A.Venkatesh Universities Press, 2008.**
3. **Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi PHI, New Delhi 2010.**

Reference Books:

1. Thermodynamics: an engineering approach. Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. Vol. 5. New York: McGraw-hill, 2011.
2. A textbook of Engineering Thermodynamics, R K Rajput, Fifth edition, Laxmi Publications, 2019.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=dS5iqnD3ff0&list=PLGiGNMkNq6QvaP6oKlr4oohTO0tob6GlB
2. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
3. https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
4. https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09oO2qcIwNNfrZ&index=3
5. https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction and Review of fundamental concepts	Importance of studying the subject, application areas are discussed in detail. Terminologies used in the subject are discussed in detail like system surroundings process properties, quasi static process and thermal equilibrium.
2	Week 3-4: Zeroth law of thermodynamics, Work and Heat	Concept of temperature, zeroth law of thermodynamics, various temperatures scales and their relationships, numerical on temperature scales are solved.
3	Week 5-6: First Law of Thermodynamics Extension of the First law to control volume	The concept of energy, energy balance, first law of thermodynamics for closed system and steady flow energy equation are discussed in detail. Numerical on first law for open and closed systems are solved.
4	Week 7-8: Second Law of Thermodynamics Entropy	The operation of heat engines, refrigerators, and heat pumps is initially explained, followed by a detailed discussion of their efficiencies and Coefficient of Performance (COP). The second part focuses on solving numerical problems related to entropy and the second law of thermodynamics.
5	Week 9-10: Pure Substances	The study begins by exploring phase change phenomena, vapor diagrams, and various pressure-temperature (P-T), pressure-volume (P-V), temperature-entropy (T-S), and

		enthalpy-entropy (H-S) diagrams. It then extends to practical applications such as interpreting data from handbooks, reading Mollier charts, and solving numerical problems based on these concepts.
6	Week 11-12: Ideal gases, Real gases	The study first delves into ideal gases, which are governed by simplified assumptions like negligible volume and no intermolecular forces. It then addresses real gases and vander waals equation later numericals are solved on these 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	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of thermodynamics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of 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

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

Continuous Internal Evaluation:

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)	3	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 Examination

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 Fundamental concepts of thermodynamics	Learn about thermodynamic systems and boundaries. Identify various types of properties (e.g., extensive and intensive properties)
2	Laws of thermodynamics	Study the basic laws of thermodynamics including, conservation of mass, and conservation of energy or first law, second law and Zeroth law.
3	Work and heat interaction	Understand various forms of energy including heat transfer and work
4	Phase change and energy interaction	Use tables, equations, and charts, in evaluation of thermodynamic properties
5	Ideal gases Real gases	Relationships between pressure, volume, temperature, limitations of the ideal gas law and real gas, calculations of gas properties using ideal and real gas equations

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

Course Outcomes (COs)

COs	Description
M23BME305.1	Apply the fundamental concepts and principles of engineering thermodynamics to compute temperature and work and heat.
M23BME305.2	Implement first law of thermodynamics to compute thermodynamic properties and energy interactions across the boundary of closed and open systems.
M23BME305.3	Evaluate performance of heat engines, refrigerators, heat pumps and entropy using second law of thermodynamics
M23BME305.4	Interpret the behavior of pure substances and their application in practical problems.
M23BME305.5	Analyze thermodynamic properties of ideal and real gas mixtures using various relations.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME305.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME305.2	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME305.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME305.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME305.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME305	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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 "Basic thermodynamics" 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 Thermal Engineering. Here are some notable contributions:

- **Applied Thermodynamics:** The knowledge gained in this course, covering principles of thermodynamic laws and governing equations, serves as a prerequisite for more advanced courses in thermal engineering. Students can delve deeper into topics such as analyzing the performance of IC engines, vapor power cycles, gas power cycles, air standard cycles and refrigeration cycles.
- **Fluid Mechanics:** Understanding thermodynamic laws and its basics serves as foundation to the course fluid mechanics. Studying thermodynamics is a must for studying fluid mechanics because it offers vital insights into the energy interactions and fluid properties that are necessary to comprehend fluid flow and behavior.
- **Heat transfer:** Since thermodynamics offers the fundamental ideas and concepts needed to comprehend how heat energy behaves and moves in various systems, it is a prerequisite for studying heat transfer.

Without a solid grounding in thermodynamics, it would be challenging to accurately study and apply heat transfer principles in practical engineering and scientific contexts.

- **Energy Engineering:** Thermodynamics equips energy engineers with the necessary knowledge to develop and improve sustainable and efficient energy solutions while minimizing environmental impact. Thermodynamics is a prerequisite for studying energy engineering because it provides essential principles of energy conservation, conversion, and efficiency, which are fundamental for analyzing and optimizing energy systems. It introduces key concepts such as the first and second laws of thermodynamics, thermodynamic cycles, properties of working fluids, and exergy analysis. These principles are crucial for designing efficient power generation, refrigeration, and renewable energy systems, understanding combustion and fuel efficiency, and managing heat transfer and energy storage.
- **Project Work and Research:** Studying basic thermodynamics is crucial for both advanced thermal engineering courses and undergraduate projects, as it provides fundamental principles of energy conservation, conversion, and efficiency. This knowledge is essential for designing and analyzing systems like heat exchangers, HVAC systems, and renewable energy solutions. It also aids in conducting experiments and solving real-world engineering problems, making it indispensable for practical engineering education.
- **Industry Applications:** Studying basic thermodynamics is vital for industry applications as it underpins the design and optimization of energy systems like power plants, HVAC systems, and refrigeration units. It ensures efficient energy conversion and utilization in processes such as combustion, heat exchange, and renewable energy generation. This foundational knowledge is essential for developing sustainable solutions, improving system efficiencies, and minimizing environmental impact in various industrial sectors.

3rd Semester	Engineering Science Course (ESC) ELECTRIC AND HYBRID VEHICLE TECHNOLOGY	M23BME306A

1. Pre-requisites

S/L	Proficiency	Prerequisites
1	**Differential Calculus, Integral Calculus, Linear Algebra**	• Understanding rates of change, derivatives, and related concepts. • Analyzing areas under curves, integrals, and applications. • Exploring vector spaces, matrices, and linear transformations. • Solving ordinary and partial differential equations relevant to engineering problems. • Differential Equations (added advantage)
2	**Electricity and magnetism, Mechanics**	• Circuits, DC/AC power, • Electromagnetism • Gravitation forces, motion, energy
3	**Statics, Dynamics**	• Forces acting on body at rest and in motion • Center of gravity of an object • Motion of rigid bodies, frictional forces, and resistance
4	**Fundamentals of science**	• Basic concepts of energy conversion and efficiency • Entropy, Enthalpy • Concept of diffusion • Difference between absorption and adsorption
5	**Computer Skills**	• Basic proficiency in using engineering software

2. Competencies

S/L	Competency	KSA Description
1	**Basics of Electronics**	**Knowledge:** Understanding of DC and AC circuits, electric motors, power electronics, working of motors and magnetism. **Skills:** • Identify key components of an electric and hybrid vehicle • Ability to analyze problems related to EV and HV systems, identify root causes, and develop solutions. • Analyze the energy flow in an electric and hybrid vehicle **Attitudes:** • Curiosity about new technologies in electric and hybrid vehicles Inclination towards sustainable development and to safeguard environment and benefits of electric vehicles
2	**Sustainable Energy Systems**	**Knowledge:** • Working of battery storage technology, fuel cells, and renewable energy sources. **Skills:** • Capacity to select appropriate battery types for specific applications • Ability to work with electronics, motors, and basic mechanical components **Attitudes:** • Awareness of safety considerations related to batteries • Commitment to continuous learning about advancements in battery technology
3	**Electric Vehicle Components**	**Knowledge:** • Familiarity with the key components of EVs and HVs, including batteries, motors, power electronics, and drive-trains. **Skills:** • Ability to analyze and interpret data related to battery performance, motor characteristics, and vehicle dynamics. **Attitudes:** • Appreciation for the importance of motor efficiency in electric vehicles • Desire to stay updated on the latest advancements in electric motor

		technology
4	**Battery Technology**	**Knowledge:** • A grasp of different battery types (Lead Acid, Lithium Ion etc.), their characteristics, parameters (capacity, discharge rate etc.), and management systems. **Skills:** • Capability to understand and potentially contribute to basic design aspects of EV/HV components or systems. **Attitudes:** • Ability to think creatively and design innovative power-train solutions • A strong interest in learning and understanding the rapidly evolving field of electric and hybrid vehicle technology.
5	**Charging Infrastructure Knowledge**	**Knowledge:** • Familiarity of different EV charging technologies, Grid-to-Vehicle (G2V), Vehicle-to-Grid (V2G), bi-directional charging, • Wireless power transfer techniques, and environmental impact considerations. **Skills:** • Stay updated on the latest advancements in charging technology **Attitudes:** • Understanding of the importance of a robust charging infrastructure for electric vehicle adoption • Commitment to promoting sustainable and efficient charging practices
6	**Regulatory Compliance and Standards Awareness**	**Knowledge:** • Must know about environmental benefits, disposal considerations • Policies related to electric and hybrid vehicles, including incentives, production-linked incentive schemes, battery swapping policies, and regulatory standards such as ARAI regulations. **Skills:** • Proficiency in researching, evaluating, and utilizing technical information from various sources. **Attitudes:** • Commitment to ethical and responsible design practices • Proactive approach to staying informed about changing regulations
7	**Problem-solving and Critical Thinking**	**Knowledge:** • Should have developed problem-solving skills • Possess critical thinking abilities to address challenges and optimize performance in the design, operation, and management of electric and hybrid vehicle systems **Skills:** • Apply critical thinking skills to diagnose and solve technical problems in electric vehicle systems • Effectively communicate technical information and solutions to others **Attitudes:** • Perseverance in tackling complex problems • Openness to new ideas and approaches • Ability to work effectively under pressure

3. Syllabus

ELECTRIC AND HYBRID VEHICLE TECHNOLOGY SEMESTER – III			
Course Code	**M23BME306A**	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 equips students with the knowledge, skills, and attitudes necessary to understand, analyze, and design electric and hybrid vehicle systems. By the end of this course, students will be able to:

1. Describe the various types of electric and hybrid vehicles and their operating principles.
2. Analyze the performance characteristics of key electric vehicle components, including batteries, electric motors, and power electronics.
3. Design and optimize electric and hybrid power-train systems for specific vehicle applications.
4. Evaluate the need for and select appropriate charging infrastructure solutions.
5. Apply critical thinking and problem-solving skills to diagnose and address technical challenges in electric vehicle technology.
6. Demonstrate awareness of regulatory compliance and industry standards for electric vehicles.

Module -1

Introduction to Electric Vehicles (EVs): Evolution of electric and hybrid vehicles; their technological aspects, Basics of electric and hybrid vehicles, Components of EVs and HVs, **Vehicle mechanics**: Roadway fundamentals, vehicle kinetics, and dynamics of vehicle motion, **Benefits and Challenges of EVs and HVs over conventional vehicles. The future scope of electric and hybrid vehicles in India and world.**

Module -2

Battery Technology: Energy storage systems and Battery basics, Types of batteries (**Lead Acid, Lithium Ion, Lithium Potassium, NiMH (Nickel metal hydride battery), Aluminium air**.), Fuel cells; types and their characteristics, Super capacitors and flywheels, **Parameters**: Capacity, discharge rate, state of charge, state of discharge, depth of discharge, Battery pack design, Properties of batteries, General architecture of EV and HV power management, Role of Battery Management Systems (BMS)

Module -3

DC & AC Electrical Machines: Motor and engine rating requirements, DC machines: Brushed and brushless DC motor drives, Three-phase AC machines, Induction machines, Permanent magnet machines, Switched reluctance machines, Interior Permanent Magnet (IPM) motor drives, **Propulsion system design** (architecture); for EVs and HVs, including different configurations (series, parallel, series-parallel, and complex), **Mechanical and Electrical Connections:** Integration of motors into drivetrain**, Compare Typical performance characteristics of gasoline engines and electric motor for traction (b***y showing the graph, traction motor characteristics*)

Module -4

Electric vehicle Drive Train, Hybrid Electric drive train for: Series, parallel, series-parallel, and complex configurations, Transmission configuration**,** Components: Gears, differential, clutch, brakes, regenerative braking**,** Motor sizing, Design considerations, Drive train sizing, **Aerodynamics and Resistance Calculations:** Rolling resistance and grade resistance**,** Acceleration force and total tractive effort**,** Torque requirements on drive wheels**,** Transmission efficiency**,** Vehicle mass considerations

Module -5

Charging Architecture for Electric and Hybrid Vehicles: Classification of different charging technology for EV charging station, Introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) operations, Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, Bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging, Environmental Impact: Environmental benefits of EVs and HVs, Disposal considerations for batteries, cells, and hazardous materials, Polices in India – Incentives, PLI (Production Linked Incentive) scheme, battery swapping policy, special E-mobility zone, Need for regulation and standards, ARAI Regulations and standards.

Textbooks:

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals," Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained," John Wiley & Sons, 2003.
3. **Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley publication ,2011.**
4. **Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009**

Reference books:

3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals," CRC Press, 2010.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems," Newnes, 2000 .

Web links and Video Lectures (e-Resources):

1. **Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at** https://nptel.ac.in/courses/108/103/108103009/
2. **Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available onNPTEL at https://**nptel.ac.in/courses/108/102/108102121/

4. Syllabus Timeline

S/L	Syllabus Timeline	Description (proposed syllabus coverage)
1	Week 1-2: Module 1: Introduction to Electric Vehicles	* Introduction and Course Overview * Evolution of Electric and Hybrid Vehicles * Technological Aspects of EVs and HVs * Introduction to Vehicle Mechanics (Roadway Fundamentals, Vehicle Kinetics) * Vehicle Mechanics (Dynamics of Vehicle Motion) * Benefits and Challenges of EVs and HVs * The Future Scope of EVs and HVs
2	Week 3-4: Module 2 Battery Technology	* Introduction to Energy Storage Systems and Battery Basics * Types of Batteries (Lead Acid, Lithium Ion, etc.) * Fuel Cells: Types and Characteristics * Super-capacitors and Flywheels * Battery Parameters (Capacity, Discharge Rate, etc.) * Battery Pack Design and Properties * General Architecture of EV and HV Power Management * Role of Battery Management Systems (BMS)
3	Week 5-6: Module 3 DC & AC Electrical Machines	* Motor and Engine Rating Requirements for EVs/HVs * DC Machines: Brushed and Brushless DC Motor Drives * Introduction to Three-Phase AC Machines * Student Presentations: Research on specific DC Machine types * Types of AC Machines (Induction, Permanent Magnet, etc.) * Switched Reluctance Machines & Interior Permanent Magnet (IPM) Motor Drives * Propulsion System Design Architectures for EVs and HVs * Mechanical and Electrical Connections: Motor Integration into drivetrain
4	Week 7-8: Module 4 Electric Vehicle Drive Train	* Hybrid Electric Drive Train Configurations (Series, Parallel, etc.) * Transmission Configuration (Gears, Differential, Clutch) * Regenerative Braking Principles and Applications * Motor Sizing and Design Considerations * Drive Train Sizing Calculations * Aerodynamics and Resistance Calculations (Rolling Resistance, Grade Resistance) * Torque Requirements on Drive Wheels and Transmission Efficiency * Vehicle Mass Considerations for Drive Train Design
5	Week 9-10: Module 5 Charging Architecture	* Classification of Charging Technologies for EV Charging Stations * Grid-to-Vehicle (G2V) and Vehicle to Grid (V2G) Operations * Vehicle to Buildings (V2B) or Vehicle to Home (V2H) Operations * Bi-directional EV Charging Systems * Energy Management Strategies in Hybrid and Electric Vehicles * Wireless Power Transfer (WPT) Technique for EV Charging * Environmental Impact of EVs and HVs * Disposal Considerations for Batteries and Hazardous Materials
6	Week 11-12:	* Policies in India: Incentives, PLI Scheme, Battery Swapping Policy, E-Mobility Zones * Need for Regulation and Standards

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 dynamics of vehicle motion concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order Thinking	Pose HOTS questions to stimulate critical thinking related to each

	(HOTS) Questions:	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

6. Assessment and Evaluation Procedure

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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	Classify and explain EV/HV types and operations	Students will gain a comprehensive understanding of the different categories of electric and hybrid vehicles, including Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Hybrid Electric Vehicles (HEVs). They will learn about their fundamental operating principles, including how electric motors and combustion engines work together in hybrid systems, and how energy flows within these vehicles.
2	Analyze key EV component performance (batteries, motors, electronics)	This objective focuses on developing students' ability to assess the performance of crucial electric vehicle components. Students will delve into the characteristics of batteries (capacity, lifespan, degradation), analyze the efficiency and power output of electric motors (AC induction, permanent magnet), and explore the role of power electronics in managing energy flow and controlling these components.
3	Design and optimize EV/HV power-trains for specific applications	Students will learn how to design and optimize the entire power-train system, which is the heart of an electric or hybrid vehicle. This includes selecting and sizing components like motors, batteries, and transmissions to meet the specific requirements of different vehicles (e.g., city car vs. performance car). Additionally, you'll explore strategies to optimize the power-train for efficiency and power delivery.
4	Evaluate and select charging infrastructure solutions	This objective broadens students' perspective to consider the infrastructure needed to support electric vehicles. Students will learn about different charging station types (AC, DC, fast charging) and understand the factors influencing charging infrastructure needs in specific locations. Through this objective, students will gain the ability to evaluate the need for charging stations and select the most suitable options for various applications.
5	Troubleshoot EV technology using critical thinking and problem-	This objective emphasizes the importance of critical thinking and problem-solving in electric vehicle technology. You'll develop the ability to apply these skills to diagnose technical issues within electric vehicle systems. Students will learn to analyze data, identify root causes of problems, and develop innovative solutions to overcome technical challenges.

	solving	
6	Understand EV regulations and industry standards	This objective highlights the importance of adhering to regulations and industry standards. Students will learn about existing regulations governing electric vehicle safety, emissions, and performance. Additionally, you'll explore established industry standards for design, manufacturing, and testing of electric vehicles. By understanding these regulations and standards, students will be equipped to design and develop electric vehicles that meet all necessary requirements.

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

Course Outcomes	Description
M23BME306A.1	**Apply** knowledge of electric vehicle components, including assessment of the development of electric and hybrid vehicle technology.
M23BME306A.2	**Analyze** the performance characteristics of electric motors compared to gasoline engines for vehicle traction applications.
M23BME306A.3	**Analyze** the working principles of different electric vehicle propulsion system configurations (series, parallel, etc.) to compare their efficiencies.
M23BME306A.4	Critically **evaluate** the environmental impact of different battery types used in electric vehicles and assess the parameter of storage medium (battery, fuel cell).
M23BME306A.5	**Design** a basic plan for an electric vehicle charging infrastructure considering factors like grid integration, user needs and policies.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME306A.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME306A.2	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME306A.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME306A.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME306A.5	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME306A	**3**	**3**	**3**										**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Module 1	**5**		**5**			**10**
Module 2		**5**		**5**		**10**
Module 3		**5**	**5**			**10**
Module 4	**5**		**5**			**10**
Module 5				**5**	**5**	**10**
Total	**10**	**10**	**15**	**10**	**5**	**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	**10**		**10**			**20**
Module 5				**10**	**10**	**20**
Total	**20**	**20**	**30**	**20**	**10**	**100**

10. Future with this Subject

The "Electric and Hybrid Vehicle Technology" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. This course equips you with the foundational knowledge and skills to be part of this exciting future in Electric and Hybrid Vehicle Technology. Here are some notable contributions:

- **Dominant Mode of Transportation:** The future is likely to see electric and hybrid vehicles becoming the dominant mode of transportation, driven by factors like decreasing battery costs, increasing efficiency, and stricter environmental regulations.
- **Battery Breakthroughs:** Advancements in battery technology are crucial. The future will likely see breakthroughs in areas like energy density (increased range), faster charging times, and improved battery life cycles, leading to more user-friendly electric vehicles.

- **Diversification of Electric Vehicles:** Beyond just cars, the future will see a wider range of electric vehicles, including trucks, buses, two-wheelers, and even commercial airplanes utilizing hybrid or electric technology.
- **Smart Charging Infrastructure:** A robust and smart charging infrastructure will be essential. The future will likely see a network of charging stations with bi-directional capabilities (V2G) for efficient energy management and integration with the power grid.
- **Autonomous Driving Integration:** Electric and hybrid vehicles are seen as a natural fit for autonomous driving technology. The future may see a convergence of these advancements, leading to cleaner and more efficient transportation systems.
- **Focus on Sustainability:** Electric and hybrid vehicles offer a significant environmental benefit. The future will likely see a continued emphasis on sustainable transportation solutions, with electric and hybrid vehicles playing a major role in reducing emissions.
- **Government Incentives and Regulations:** Government policies can significantly impact the adoption of electric vehicles. The future will likely see continued support through incentives like tax breaks or subsidies, along with stricter regulations on conventional vehicles.
- **Skilled Workforce Development:** The widespread adoption of electric and hybrid vehicles will require a skilled workforce. The future will likely see a demand for engineers, technicians, and other professionals with expertise in this technology.

3rd Semester	Engineering Science Course (ESC) SMART MATERIALS AND SYSTEMS	M23BME306B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Material Science	Understanding of Material Science. Familiarity with fundamental Material Science concepts such as material properties, structure, phases, homogeneous and heterogeneous mixtures
2	Mechanical Engineering Science	Knowledge of basic material compositions. Understanding of types of materials and properties of materials. materials (Polymers and Ceramics)
3	Mechatronics	Understanding of Piezo-electricity, sensors (Piezo-electric sensor, strain gauge, shear sensor, in-plane and out of plane sensor, accelerometer)
4	Civil Engineering	Knowledge of building components and infrastructure, modular coordination, standardization, materials, systems, production, transportation and installation.
5	3D Modelling	knowledge of manufacturing production and processes, to be thorough and pay attention to detail. knowledge of engineering science and technology. analytical thinking skills. the ability to analyze quality or performance.

2. Competencies

S/L	Competency	KSA Description
1	**Material Structure**	**Knowledge:** Understanding of types of materials and metallurgical aspects of materials. **Skills:** Ability to analyze material properties based on structure, Proficiency in selecting appropriate materials for specific applications. **Attitudes:** Ability to think critically and creatively to develop new materials
2	**Mechatronics**	**Knowledge:** Understanding of how mechanical, electrical, and control systems interact **Skills:** Troubleshoot and maintain complex mechatronic systems, Adapt to new technologies and industry trends **Attitudes:** Adjusts to different work environments and dynamics with a positive attitude
3	**Building components and Infrastructure**	**Knowledge:** Understanding of Properties and applications of building components (beams, columns, walls, etc.), Construction methods for different building elements (foundations, walls, roofs, etc.). **Skills:** Select materials based on structural needs, cost, and environmental factors. **Attitudes:** Seeks out opportunities to learn new technologies and components, adapts to changes in technology and infrastructure requirements.
4	**3D Printing**	**Knowledge:** Knows different types of 3D printers and their capabilities, familiar with various 3D printing materials and their properties, knowledge of 3D modeling software - Stays up-to-date on the latest advancements in 3D printing **Skills:** Can operate different types of 3D printers safely and efficiently, can design and create 3D models for printing **Attitudes:** Has a strong attention to detail, creative and innovative, adaptable and willing to learn new things.

3. Syllabus

Smart Materials and systems **SEMESTER – III**			
Course Code	**M23BME306B**	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	Total Marks	**100**
Credits	3	Exam Hours	**03**

Course objectives

1. To develop the student's ability to learn emerging materials.
2. To make students to learn prefabricated building components
3. To understand the sensors deployed in smart buildings
4. To learn building information modelling for building design
5. To learn the concepts of 3-D printing

Module -1	
Emerging Materials Honey comb structure (Carbon composites), Nano-materials, engineered polymers, emerging sustainable by products (Fly ash and GGBS) and construction chemicals	L1, L2, L3
Module -2	
Prefabricated/ Manufactured building components Definition, types of prefabricated/ manufactured building components and infrastructure, modular coordination, standardization, materials, systems, production, transportation and installation.	L1, L2, L3
Module -3	
Smart Materials Definition, Principles of Piezo-electricity, materials (Polymers and Ceramics), sensors (Piezo-electric sensor, strain gauge, shear sensor, in-plane and out of plane sensor, accelerometer), smart composites	L1, L2, L3
Module -4	
BIM and IBMS BIM: Definition, Necessity, advantages, BIM in building design, infrastructure design and construction IBMS – Definition, Necessity, advantages, Types of IBMS	L1, L2, L3
Module -5	
3-D Printing Importance, Historic development, advantages, common terminologies, classification, Process chain, 3 – D modelling, Data conversion and transmission, checking and preparation, Building, Post processing, Applications	L1, L2, L3

Suggested Learning Resources:

Books

1. Essentials of Materials Science and Engineering, Donald R. Askeland and Pradeep P. Fulay, Cengage Learning, 2009.
2. Smart materials actuators: Recent advances in characterization and applications, Choi, S.B. & Kim, J. 2015
3. Smart Materials and Structures, Inman, D.J, International Centre for Mechanical Sciences, vol 488, 2007

References:

1. Smart Material Systems: Model Development, Ralph C. Smith, Volume 32 of Frontiers in Applied Mathematics, 2005.
2. Smart Materials and Structures, M.V. Gandhi, B.D. Thompson, Springer Science & Business Media, 31 May 1992.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	**Emerging Materials:** Honey comb structure (Carbon composites), Nano-materials, engineered polymers.
2	Week 3-4	Emerging sustainable by products (Fly ash and GGBS) and construction chemicals. **Prefabricated/ Manufactured building components:** Definition, types of prefabricated/ manufactured building components and infrastructure, modular coordination, standardization, materials, systems,
3	Week 5-6	Production, transportation and installation**. Smart Materials:** Definition, Principles of Piezo-electricity, materials (Polymers and Ceramics), sensors (Piezo-electric sensor, strain gauge, shear sensor, in-plane and out of plane sensor, accelerometer), smart composites
4	Week 7-8	**BIM and IBMS:** BIM: Definition, Necessity, advantages, BIM in building design,

		infrastructure design and construction IBMS – Definition, Necessity, advantages, Types of IBMS
5	Week 9-10	**3-D Printing:** Importance, Historic development, advantages, common terminologies, classification, Process chain, 3 – D modelling,
6	Week 11-12	Data conversion and transmission, checking and preparation, Building, Post processing, Applications. **Revisions.**

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 smart materials 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)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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	Identify Emerging Materials	Students will learn to recognize and categorize various emerging materials, such as nanomaterials, biomaterials, advanced polymers, and smart materials. This includes understanding their classifications and unique attributes
2	Identify Prefabricated Building Components	Students will learn to recognize and categorize various types of prefabricated building components, including panels, modules, and complete systems. They will understand the different materials and construction techniques used.
3	Smart material Properties and Mechanisms	Students will become proficient in recognize and categorize various types of smart materials. They will understand the unique characteristics that define smart materials. They will understand how smart materials respond to external stimuli such as temperature, pressure, electric fields, and magnetic fields.
4	Introduction to BIM and IBMS	Students will learn the basics of Building Information Modeling (BIM) and Integrated Building Management Systems (IBMS), including definitions, key concepts, and the

		differences between them. They will understand the importance and benefits of these technologies in modern construction and building management.
5	Introduction to 3-D Printing	Students will learn the basics of 3-D printing, including its history, evolution, and key concepts. They will understand the fundamental principles of additive manufacturing and how it differs from traditional subtractive manufacturing techniques.

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

Course Outcomes (COs): Students will be able to

COs	Description
M23BESC306B.1	**Relate** the structure and properties of emerging materials.
M23BESC306B.2	**Illustrate** the properties of Piezo-electricity, materials, sensors and smart composites
M23BESC306B.3	**Interpret** the strategies for effective data exchange between BIM and IBMS.
M23BESC306B.4	**Analyze** the prefabricated/manufactured building components for efficient and sustainable construction.
M23BESC306B.5	**Classify** different 3D printing technologies based on their processes and materials.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BESC306B.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BESC306B.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
M23BESC306B.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BESC306B.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BESC306B.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
M23BESC306B	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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

Studying smart materials and systems opens a wide range of career opportunities and pathways for students, given the interdisciplinary nature and growing importance of this field.

Studying smart materials and systems equips students with a versatile skill set applicable to a wide range of industries and roles. They will be at the forefront of innovation, contributing to technological advancements and addressing some of the most pressing challenges in various sectors. The interdisciplinary nature of this field ensures that students can find opportunities that align with their interests, whether in research, industry, entrepreneurship, or beyond.

3rd Semester	Engineering Science Course (ESC) INTERNET OF THINGS	M23BME306C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Electrical Engineering Knowledge	Understanding the fundamentals of circuits, transistors, resistors, capacitors, and how to read circuit diagrams and Knowledge of microcontrollers.
2	Fundamental Programming knowledge	Proficiency in languages such as Python, C, C++, and Java. Python is particularly popular for IoT due to its ease of use and extensive libraries.
3	IOT Development platforms	Familiarity with IoT development platforms like Arduino IDE, Node-RED, and platform-specific SDKs.
4	Computer networks	Understanding basic networking protocols of IoT like HTTP etc.
5	IOT Security	Understanding of encryption techniques and authentication methods to secure IoT devices and data.

2. Competencies

S/L	Competency	KSA Description
1	Basics of IOT	**Knowledge**: Understanding the concepts of IoT and its architecture, components **Skills**: Interfacing of IOT with the physical and digital worlds **Attitudes:** A commitment to staying updated with the latest trends, technologies, and best practices in IoT.
2	IOT Protocols	**Knowledge**: Understanding the concepts of IOT **Skills**: Understanding networking protocols of IoT (HTTP, MQTT, CoAP, BLE). **Attitudes**: Striving for high-quality work and thorough testing of IoT systems to ensure reliability and efficiency
3	Web Development	**Knowledge**: Understanding WOT tools and architecture **Skills**: Knowledge of encryption methods to secure data transmission. **Attitudes:** Applying WoT principles to connect and manage industrial equipment, enhancing efficiency and predictive maintenance.
4	System design and Integration	**Knowledge**: Understanding Components of IOT and its architecture **Skills**: Ability to build IoT circuits using development boards and various sensors. **Attitudes**: Managing IoT projects, including planning, execution, and monitoring.

3. Syllabus

Internet of Things SEMESTER – III			
Course Code	M23BME306C	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

The Internet is evolving to connect people to physical things and also physical things to other physical things all in real time. It's becoming the Internet of Things (IoT). The course enables student to

1. Understand the basics of Internet of things and protocols.
2. Understand the application areas where Internet of Things can be applied.
3. Learn about the middleware for Internet of Things.
4. Apply the concepts of Web of Things in interfacing systems.

Module -1		
IOT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.		
Pedagogy	Chalk and Talk, Power point Presentations	**08 Hours**

Module -2		
IOT PROTOCOLS - Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4– BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security		
Pedagogy	Chalk and Talk, Power point Presentations	**08 Hours**

Module -3		
IOT ARCHITECTURE - IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.		
Pedagogy	Chalk and Talk, Power point Presentations	**08 Hours**

Module -4		
WEB OF THINGS - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.		
Pedagogy	Chalk and Talk, Power point Presentations	**08 Hours**

Module -5		
IOT APPLICATIONS - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.		
Pedagogy	Chalk and Talk, Power point Presentations, Real time examples, Lab Demonstration	**08 Hours**

Text Books

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.

References Books:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013
3. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1- 4493-9357-1

Web links and Video Lectures (e-Resources):

Introduction to IoT –
https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE

https://www.coursera.org/learn/beginning-custom-projects-with-raspberry-pi
https://www.edx.org/course/introduction-to-the-internet-of-things-3

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

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11/22 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: IOT	**IOT** - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.
2	Week 3-4: IOT Protocols	**IOT PROTOCOLS** - Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security
3	Week 5-6: IOT Architectures	**IOT ARCHITECTURE:** IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.
4	Week 7-8: Web On Things	**Web On Things** : Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.
5	Week 9-10: IOT Applications	**IOT APPLICATIONS** - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications.
6	Week 11-12: IOT Applications	Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Chalk & talk, PPT	Utilize various teaching methods within the lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding of IOT concepts
3	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies like LED's, temperature control etc.
4	Lab Demonstration	The working of transducers, sensors and actuators can be demonstrated in the laboratory using Arduino or raspberry pi.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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)	3	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 Examination

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	Basics of IOT	Students will grasp the fundamental concepts of IOT, Components of IOT and architecture of IOT. This provides a commitment to staying updated with the latest trends, technologies, and best practices in IoT.
2	IOT Protocols	Basic understanding of IP addressing, DNS, and networking protocols relevant to IoT (HTTP, MQTT, CoAP, BLE).
3	System Design and Integration	Ability to diagnose and fix issues in IoT systems, from hardware malfunctions to software bugs.
4	Project-Based Learning	A small mini project can be taken up for better understanding of sensors, actuators in IOT systems interfacing platforms like Arduino Uno, raspberry pi etc.

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

Course Outcomes (COs)

COs	Description
M23BME306C.1	Apply the concepts of IOT, trends and security issues during implementation into a real world scenario.
M23BME306C.2	Configure and use different IOT protocols for device communication
M23BME306C.3	Compare various IOT architectures to identify the best fit for suitable application.
M23BME306C.4	Asses and optimize WoT application that integrates sensors with a web server using various platforms.
M23BME306C.5	Evaluate and intrepret new IoT applications for various industries.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME306C.1	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME306C.2	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME306C.3	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME306C.4	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME306C.5	**3**	**3**	-	-	**3**	-	-	-	-	-	-	-	-	**3**
M23BME306C	**3**	**3**	-	-	**3**	-	-	-	-	-	-	-	**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 "Internet of Things" course in the 4th 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 Industry 4.0 and smart manufacturing, Smart cities, Climate change monitoring, automotive industry, etc

The future of IoT promises significant advancements and benefits across various domains. With continuous innovation and increasing integration of IoT technologies, we can expect a smarter, more efficient, and connected world. However, addressing security, privacy, and ethical challenges will be crucial to realizing the full potential of IoT.

In summary, the "Internet of Things" course serves as a stepping stone, equipping students with the opportunities across multiple industries. As technology advances, the role IOT in creating smarter, more efficient, and more reliable systems will continue to grow, driving innovation and improving quality of life. The fundamental knowledge and skills that is essential for the subsequent courses in their B.E program and for their future careers in various technology-related fields.

3rd Semester	Engineering Science Course (ESC) WASTE HANDLING AND MANAGEMENT	M23BME306D

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Science Knowledge	Understanding of basic biology, chemistry, and physics, as waste management often involves chemical reactions, biological processes, and physical properties of materials.
2	Environmental Science	Foundational knowledge in environmental science to understand the impact of waste on ecosystems and human health.
3	Engineering Principles	Basic engineering principles, particularly in civil and environmental engineering, to design and manage waste treatment systems.
4	Mathematics	Basic mathematical skills for calculations and measurements involved in waste management
5	Previous Coursework	Completion of introductory courses in Environmental Science and Engineering or a related field

2. Competencies

S/L	Competency	KSA Description
1	**Basics of waste management**	**Knowledge:** Understanding the basics of solid waste management (SWM), elements of SWM **Skills:** Ability to identify and classify different types of waste based on their physical, chemical, and biological properties **Attitudes:** Appreciating the importance of solid waste management towards sustainable development
2	**Waste characterization**	**Knowledge:** Understanding the different types of wastes, waste generation and composition **Skills:** Ability to identify and classify different types of waste based on their physical, chemical, and biological properties **Attitudes:** Valuing the importance of waste characterization in solid waste management
3	**Treatment Technologies**	**Knowledge:** Understanding various waste treatment technologies. **Skills:** Capable of managing waste treatment technologies such as recycling, composting, incineration, and landfill management. **Attitudes:** Valuing natural resources and actively seeking ways to minimize waste and conserve resources.
4	**Resource Recovery**	**Knowledge:** Understanding the importance of resource recovery and recycling to minimize waste and promote sustainability. **Skills:** Skills in identifying and utilizing opportunities for resource recovery and recycling to minimize waste and promote sustainability. **Attitudes:** Valuing the importance of resource recovery and recycling to minimize waste and promote sustainability.
5	**Hazard waste Identification and Classification**	**Knowledge:** Understanding the types of hazardous waste ,importance of hazardous waste treatment **Skills:** Ability to Identify and classify various hazardous waste, **Attitudes:** Valuing the importance of hazardous waste management to minimize waste and promote sustainability

3. Syllabus

WASTE HANDLING AND MANAGEMENT **SEMESTER – III**			
Course Code	M23BME306D	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**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives: This course will enable students to:
1.Waste generation & effects
2.Solid waste management & challenges
3.Hazordous waste management & challenges
4.Innovative methods in practice to handle waste & its effects
5.Laws governing the waste management

Module -1: Introduction to Solid Waste Management	
Importance, methods of logistics, human components, technological components- waste handling equipment and technology, steps in waste management logistics. Waste collection system and organization: Environmental aspects of waste collection, role of public authority and private sector in waste collection, organizing collection of residential waste, fee schemes, public awareness programs.	L1, L2,L3
Module -2: Engineering Systems for Solid Waste Management	
Characteristics of solid waste, types of solid waste, Processing and Treatment of Solid Waste; Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Types of Material Recovery Facilities, Biological Treatment & Biological methods for waste processing; Composting & methods. Biomethanation, Biodiesel, Biohydrogen, Mechanical Biological Stabilization, Thermal Treatment Incineration, Residues and its utilization, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel. Engineering Disposal of SW: Dumping of solid waste; sanitary landfills – site selection	L1, L2, L3
Module -3: Hazardous Waste Management	
Introduction, Hazardous waste definition, sources, identification and classification, Characteristics, Industrial waste & Plastic Waste; sources, environmental effects, challenges in handling Biomedical waste; Introduction to biomedical wastes, sources, classification, collection, segregation, treatment and disposal, E-waste; characteristics, generation, collection, transport, recycling and disposal, Effects on the society and environment, Transportation and Disposal, recycling and reuse, Nuclear waste; Characteristics, Types, Power reactors, Refinery and fuel fabrication wastes, Health and environmental effects, Decommissioning of Nuclear power reactors Hazardous waste landfills, Site selections.	L1, L2, L3
Module -4: Innovations in waste management	
Global and Indian Context, recycling, reuse, energy production, land filling, remediation of hazardous waste contaminated sites. Revenue models, Developing Networks, Entrepreneurship activities, Best practices in India and Abroad- Case studies, Waste management and waste handling entrepreneurs in India and other countries, Case studies of different municipalities waste handling techniques, domestic composting, medium & large scale composting, Centralised composting	L1, L2, L3
Module -5:Waste Management Laws in India	
The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001. Duties of constitutional bodies and Ministries	L1, L2, L3

Suggested Learning Resources:
Books

1. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
2. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
3. Strategic Management, Hitt, M.A.,Hoskisson, R.E., Ireland, R.D., (2016)., Cengage Learning, India.
4. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
5. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition

Reference books:
1. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel (2014)., 2nd Ed., CRC Press, USA.
2. Waste: A Handbook for Management, Letcher, T.M., Vallero, D.A. (2011)., 1st Ed, Academic Press, USA.
3. Waste Management Strategy and Action Plan,IGES, UNEP, CCET. (2018), Phnom Penh 2018-2035. Phnom Penh, Cambodia.
4. National Environment Policy, 2006, Ministry of Environment and Forests, Government of India, Approved by the Union Cabinet on 18 May, 2006 2
5. Innovation and Entrepreneurship, Peter Drucker, (2012)., Routledge Publishers, England UK

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	•Importance, methods of logistics, human components, technological components- waste handling equipment and technology, steps in waste management logistics. •Waste collection system and organization: Environmental aspects of waste collection, role of public authority and private sector in waste collection, organizing collection of residential waste, fee schemes, public awareness programs.
2	Week 3-4	Characteristics of solid waste, types of solid waste, Processing and Treatment of Solid Waste; Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Types of Material Recovery Facilities, Biological Treatment & Biological methods for waste processing; Composting & methods. Biomethanation, Biodiesel, Bio hydrogen, Mechanical Biological Stabilization, Thermal Treatment Incineration, Residues and its utilization, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel. •Engineering Disposal of SW: Dumping of solid waste; sanitary landfills – site selection
3	Week 5-6	Introduction, Hazardous waste definition, sources, identification and classification, Characteristics, Industrial waste & Plastic Waste; sources, environmental effects, challenges in handling Biomedical waste; Introduction to biomedical wastes, sources, classification, collection, segregation, treatment and disposal, E-waste; characteristics, generation, collection, transport, recycling and disposal, Effects on the society and environment, Transportation and Disposal, recycling and reuse, Nuclear waste; Characteristics, Types, Power reactors, Refinery and fuel fabrication wastes, Health and environmental effects, Decommissioning of Nuclear power reactors Hazardous waste landfills, Site selections.
4	Week 7-8	Global and Indian Context, recycling, reuse, energy production, land filling, and remediation of hazardous waste contaminated sites. Revenue models, Developing Networks, Entrepreneurship activities, Best practices in India and Abroad- Case studies, Waste management and waste handling entrepreneurs in India and other countries, Case studies of different municipalities waste handling techniques, domestic composting, medium & large scale composting, Centralised composting
5	Week 9-10	The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001. Duties of constitutional bodies and Ministries.

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.
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

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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	Understand Types of Waste	Students would able to Identify and classify different types of waste, including municipal, industrial, hazardous, and electronic waste.
2	Familiarize with Waste Management Processes	"Students understand the processes involved in waste collection, transportation, treatment, and disposal."
3	Comprehend Environmental Impact	Students Understand the environmental impacts of improper waste management and the benefits of sustainable practices
4	Conduct Environmental Assessments	Students Learn how to conduct environmental impact assessments and risk analyses related to waste management activities.
5	Communication Skills	Students Learn to communicate waste management strategies and policies effectively to different audiences.
6	Ethical and Professional Responsibility	Students Cultivate an understanding of the ethical considerations in waste management, including environmental justice and corporate social responsibility.

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

Course Outcomes (COs)

COs	Description
M23BME306D.1	Apply knowledge of different types of waste to assess their characteristics and evaluate potential environmental and human health impacts.
M23BME306D.2	Interpret waste segregation principles to formulate an effective system for waste collection and disposal
M23BME306D.3	Recognize hazardous waste characteristics to propose effective treatment and disposal methods, demonstrating understanding of waste management principles.
M23BME306D.4	Employ entrepreneurial and analytical skills to investigate global and Indian waste management practices, proposing innovative and sustainable solutions
M23BME306D.5	Assess constitutional duties of Indian waste management laws and thereby enhancing understanding of the legal framework governing waste management.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME306D.1	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME306D.2	**3**	-	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME306D.3	**3**	-	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME306D.4	**3**	-	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME306D.5	**3**	-	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME306D	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

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

10. Future with this Subject

The "waste handling and management" course in the third semester of the B.E program lays a strong foundation for several future courses in various engineering disciplines, emphasizing its interdisciplinary nature and importance in sustainable development. Here are some notable contributions:

Materials Science and Engineering: Waste handling involves dealing with various materials, which helps you learn about their properties, degradation processes, and lifecycle. This knowledge is crucial in Materials Science and Engineering for developing materials that are durable, recyclable, and sustainable.

Renewable Energy Systems: Waste Handling and Management covers the processes and technologies used to the processes involved in waste collection, transportation, treatment, and disposal. This knowledge is directly applicable to renewable energy systems that utilize waste-to-energy technologies, such as incineration, anaerobic digestion, and gasification.

3rd Semester	Professional Core Laboratory (PCL) INTRODUCTION TO MODELLING AND DESIGN FOR MANUFACTURING	M23BMEL307

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic knowledge of Drawing	Machine drawing builds on the principles of basic engineering drawing, including understanding projections, section views, dimensioning, and tolerances. Analyzing the principle of orthographic projections and draw the views as per bureau of Indian standards.
2	Geometry and Trigonometry	A strong grasp of geometric and trigonometric concepts is essential for accurately representing and interpreting the shapes and angles in machine components
3	Material Science	Knowledge of material properties helps in selecting the right materials for different components and understanding how they should be depicted in drawings.
4	Mechanical engineering Fundamentals	Knowledge of basic mechanical engineering concepts such as forces, moments, materials, and their properties is crucial for understanding how machine parts function and how they should be represented in drawings.
5	CAD Software usage	Proficiency in CAD software like AutoCAD, Solid-edge, Solid-Works, or similar tools is often necessary, as these tools are used for creating precise and detailed drawings digitally.

2. Competencies

S/L	Competency	KSA Description
1	Analyzing orthographic projection	**Knowledge:** Proficiency knowledge of engineering drawing **Skills:** Ability to analyze and draw orthographic views of product **Attitudes:** Importance of orthographic projections with GD and T.
2	Concepts of standardization and GD and T	**Knowledge:** Understanding the bureau of Indian standards in drawing **Skills:** Analyzing the views and dimensions and tolerances. **Attitudes:** Appreciation of importance of using GD and T in drawings.
3	Interpretation of drawing vies in thread forms, fasteners	**Knowledge:** BIS Standard for threads, Bolts, nuts, washers and studs **Skills:** Application of V and square threads in threaded fasteners **Attitudes:** Commitment to Precision, Continuous Learning
4	Joints, Coupling and assembly drawings	**Knowledge:** Analyzing and visualization of part drawing Understanding Material properties **Skills:** Drawing interpretation, Spatial visualization, CAD Proficiency **Attitudes:** Commitment to Precision, Continuous Learning, Analytical Mind set, Ethical Responsibility

3. Syllabus

INTRODUCTION TO MODELLING AND DESIGN FOR MANUFACTURING SEMESTER – III			
Course Code	M23BMEL307	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:0:2*:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**14 Sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

***One hour per week can be taken additionally**

Course objectives: This course will enable students to:

1. To develop the visualization skills and enable the students with concepts of standard conventions applied in engineering drawings.
2. To inculcate principles of projection and make drawings using orthographic projections and sectional views.
3. To impart fundamental knowledge of drawing of different machine parts.
4. To enable the students to draw the assembly of various machine components.
5. To enable the students on limits, tolerance and fits and indicate them on machine drawings.

Module -1

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. ***(Above topics to be studied as a review). (CIE only)***

Orthographic Projections: Conversion of pictorial views into orthographic projections of simple machine parts without sections. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines

The basics of sketching and modeling: Review of graphic interface of the software. Review of 2D Sketching, Parametric; create new projects and designs, creating basic 2D sketches, Creating & Modifying a solid 3D body with sections. Create draft during a feature - Create draft as a feature - Add ribs and plastic supports - Create holes and threads - Mirrors and patterns

The different ways to create components - Use scripts to create gears - Component color swatch and color cycling - Use McMaster-Carr parts in a design

Pedagogy	Chalk and talk, Power point presentation, Use of CAD software	02 Sessions

Module -2

Thread Forms: Terminologies, ISO Metric, BSW, Sellers threads, Square & Acme threads.

Fasteners: 3D & Section views- Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts.

Pedagogy	Chalk and talk, Use of CAD software	02 Sessions

Module -3

Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. (Part drawings shall be given)

Couplings: Flanged coupling, universal coupling (Part drawings shall be given)

Pedagogy	Chalk and talk, Use of CAD software	04 Sessions

Module -4

Assembly Drawings: (Part drawings shall be given)

Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.

1. **Screw jack**
2. **Plummer block**
3. **Machine vice**
4. **Lathe square tool post**
5. **Connecting rod**
6. **Rams bottom Safety valve**

Pedagogy	Chalk and talk, Use of CAD software	06 Sessions

SOFTWARE

The use of any equivalent 3D CAD software is allowed like Solid edge, Auto Desk fusion 360, Solid works, AutoCAD, CREO etc.

Text Books:

1. K L Narayana, P Kannaiah, K Venkata Reddy, “Machine Drawing”, New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006

2. N.D.Bhat, 'Machine Drawing' Charotar Publishing House Pvt. Ltd., 50th Edition, ISBN-13:978-9385039232, 2014.
3. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Web links and Video Lectures (e-Resources):

- **Learn Fusion 360 in 90Minutes**
  https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
- **Introduction to Modelling and Design for manufacturing**
  https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional
- **Video Lectures**
  https://www.youtube.com/watch?v=kxRbD_gtlJI&list=PLGiGNMkNq6QsSHEfUC1ekc2Pz2gfy1OKb

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Limits Fits & Tolerances & Orthographic projections	**Limits, Fits and Tolerances:** Introduction, Fundamental tolerances, Deviations, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. **Orthographic Projections:** Conversion of pictorial views into orthographic projections of simple machine parts without sections. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines
2	Week 3-4: Thread forms and fasteners	**Thread Forms:** Terminologies, ISO Metric, BSW, Sellers threads, Square & Acme threads. **Fasteners:** 3D & Section views- Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts.
3	Week 5-6: Assembly and Joints and Coupling	**Assembly:** Screw jack**,** Pedastal bearing **Joints:** Cotter joint knuckle joint (pin joint) for two rods.
4	Week 7 to 12 Assembly drawings & Joints and Coupling	**Assembly:** Machine Vice**,** Lathe square tool post, Piston **Couplings**: Flanged coupling, universal coupling

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Chalk and Talk method	The drawing views are explained using chalk and talk method
2	Videos Demonstration and Simulations	The assembly drawings are explained with the help of videos and simulations.
3	Use of Charts	The use of charts enables better visualization to students.
4	Software	Assign modeling and drafting tasks to reinforce practical skills associated with competencies.

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation

- 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 for 100 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 20marks (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 50 marks

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	Develop Visualization skills and to apply IS standards in drawings	Students must have imagination ideas and need to visualize the component. The students need to capable of implementing standardization as per bureau of Indian standards in any part drawings.
2	Apply the principle of orthographic projections	Students need to apply the principles of orthographic projection while drawing in a machine part
3	Analyze the part drawing and draw Assembly drawing as per standards	The proficiency of understanding the part drawings is very essential to draw assembles components and to draft the same in the CAD software
4	Usage of equivalent CAD Software package	The CAD software supports modern tool usage. The students can draft the component and can modify the drawings in CAD software. The proficiency of understanding the features of modeling tool is must and necessary in industry 4.0 environment.

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

Course Outcomes (COs)

COs	Description
M23BMEL307.1	Utilize Geometrical dimension and tolerance (G D & T) technique to draw the profiles of thread-forms and orthographic views of different types of machine parts and fasteners
M23BMEL307.2	Construct the different types of joints and couplings used in mechanical systems.
M23BMEL307.3	Produce the assembly drawings using part drawings which enables lifelong learning using sketching and drawing as communication tool.
M23BMEL307.4	Create 3D models of machine components and assemble the parts using CAD packages.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BMEL307.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BMEL307.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BMEL307.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BMEL307.4	-	-	-	-	-	-	-	-	-	3	-	3	3	-
M23BMEL307	**3**	-	-	-	**3**	-	-	-	-	**3**	-	**3**	**3**	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	**Total**
Module 1	**05**			**10**	**15**
Module 2	**05**			**10**	**15**
Module 3		**10**		**20**	**30**
Module 4			**10**	**30**	**40**
Total	**10**	**10**	**10**	**70**	**100**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	**Total**
Module 1/2	**05**			**15**	**20**
Module 3		**10**		**20**	**30**
Module 4			**10**	**40**	**50**
Total	**05**	**10**	**10**	**75**	**100**

10. Future with this Subject

The "Introduction to Modeling and Design for Manufacturing" course in the third semester of the B.E program lays a strong foundation for several future courses in the undergraduate program. The future of machine drawing is characterized by increased precision, efficiency, and collaboration, driven by advancements in CAD software, AI and cloud computing, technologies. These innovations are transforming how machine drawings are created, shared, and utilized, leading to better-designed machines, faster production times, and significant cost savings. In summary, the "Introduction to modeling and design for manufacturing" 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			
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 - Activities Report Evaluation by College NSS Officer / HOD / Sports Dept / Any Dept.			

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 in mobilizing 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 ONE TREE)

They will also make an excerpt, either as a documentary or a photo blog, describing the plant's origin, its usage in daily 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 campus Objectives, 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, case study, Report, outcomes.

Course outcomes (Course Skill Set):

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

Cos	Description
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 evaluation

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.	**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 / 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
4.	**Water conservation & Conservation Techniques:**	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 Faculty
5.	**Food walk: Practices in society**	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 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 activity progress 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**	• Implementation strategies of the project (NSS work).
Commencement of activities and its progress	**20 Marks**	• The last Report should be signed by the NSS Officer, the HOD, and the principal.
Case Study-based Assessment Individual Performance with Report	**20 Marks**	

Sector-wise study & its consolidation 5*5 = 25	**25 Marks**	• 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 1 to 5, 5*5 = 25	**25 Marks**	
Total marks for the course in each semester	**100 Marks**	
For each activity, 20 marks CIE will be evaluated for IA marks at the end of the semester. Report and assessment 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) ADVANCED PYTHON PROGRAMMING	M23BEM309A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Programming Fundamentals	Strong foundation in Python programming - Variables, data types, operators, control flow - Functions (defining, calling, arguments, return values) - Basic object-oriented programming concepts - File I/O (reading and writing data)
2	Data Structures	Familiarity with basic data structures (lists, tuples, dictionaries)
3	Programming Experience	Comfortable writing basic Python programs and solving computational problems
4	Additional Programming Knowledge	Familiarity with a general-purpose programming language (e.g., C, Java) (advantageous)
5	Software and Environment	Access to a computer with Python installed - Basic understanding of text editors or IDEs
6	Mathematics	Prior exposure to mathematical concepts (linear algebra, calculus)

2. Competencies

SL. No	Competency	KSA Description
1.	Data Manipulation and Analysis	**Knowledge:** Advanced string manipulation techniques (regular expressions) Data structures (lists, tuples, dictionaries, sets) and their operationsFile I/O for reading and writing various data formats. **Skills:** Writing Python code to process and analyze data sets Implementing algorithms for data cleaning, transformation, and aggregation. **Attitudes:** Problem-solving approach to identify and apply appropriate data manipulation techniques. Curiosity to explore different data sets and uncover insights.
2.	Functional Programming	**Knowledge:** Higher-order functions, lambda expressions, functional constructs **Skills:** Designing functions that operate on other functions (functional composition) **Attitudes:** Appreciation for code that is concise, modular, and reusable
3.	Exception Handling and Debugging	**Knowledge:** Different types of exceptions and their handling mechanisms **Skills:** Writing robust code that can gracefully handle errors and unexpectedsituations. Debugging techniques (using print statements, debuggers, logging) **Attitudes:** Attention to detail to identify potential errors in code.
4.	Working with Modules and Packages	**Knowledge:** Searching for and installing Python modules and packages. Utilizing external libraries to extend Python's functionality**Skills:** Effectively importing and using functions from different modules. **Attitudes:** Openness to using existing code written by others

5.	Scientific Computing with NumPy	**Knowledge:** NumPy arrays, operations, linear algebra functions **Skills:** Writing Python code that performs numerical computations efficiently Solving problems involving matrices, vectors, and linear algebra. **Attitudes:** Interest in applying Python to scientific and engineering contexts

3. Syllabus

ADVANCED PYTHON PROGRAMMING SEMESTER – III			
Course Code	M23BMEC309A	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:0:2)**	SEE Marks	**50**
Total Number of Lecture Hours	15 Sessions	Total Marks	**100**
Credits	**01**	Exam Hours	**02**

Course objectives: This course will enable students to:

1. To learn the basic programming constructs in Python.
2. To Design and implement complex Python programs that leverage advanced techniques.
3. To apply data structures and algorithms effectively to solve problems.
4. To Work with numerical data using NumPy.
5. To handle file I/O and exception management.
6. To understand the problem solving approaches.
7. To practice various computing strategies for Python-based solutions to real world problems.

EXPERIMENTS	
1.	Demonstrate following functions/methods which operates on strings in Python with suitable examples: i) len( ) ii) strip( ) iii) rstrip( ) iv) lstrip( ) v) find( ) vi) rfind( ) vii) index( ) viii) rindex(),ix) count( ) x) replace( ) xi) split( ) xii) join( ) xiii) upper( ) xiv) lower( ) xv) swapcase( ) xvi) title( ) xvii) capitalize( ) xviii) startswith() xix) endswith()
2.	Implementing programs using Functions. (Factorial, largest number in a list, area of shape).
3.	NESTED LISTS: Write a program to read a 3 X 3 matrix and find the transpose, addition, subtraction, multiplication of two 3 X 3 matrices, check whether two given 3 X 3 matrices are identical or not.
4.	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters).
5.	Scientific problems using Conditionals and Iterative loops. (Number series and different Patterns).
6.	Numpy Library: Linear Algebra Write a python program to find rank, determinant, and trace of an array. Write a python program to find eigen values of matrices d) Write a python program to solve a linear matrix equation, or system of linear scalar equations.
7.	Graphics: • Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Use object oriented approach. • Design a Python program using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.
8.	Create a colour images using NumPy in Python.

Demonstration Experiments (For CIE only – not to be included for SEE)	
1.	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word).
2.	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter‟s age validity, student mark range validation).

Text Books:

1. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introductionand Experiment -1	Introduction to Python Programming, briefing about concepts learnt in lower semester. Functions/methods which operates on strings in Python
2	Week 3-4: Experiment -2and Experiment-3	Implementing programs using Functions. Nested Lists
3	Week 5-6: Experiment -4and Assessment -01	Implementing programs using Strings. Assessment -1 to be scheduled after the completion of 4 experiments
4	Week 7-8: Experiment -5and Experiment-6	Scientific problems using Conditionals and Iterative loops. Numpy Library
5	Week 9-10: Experiment -7 and Experiment-8	Graphics Create a colour images using NumPy in Python.
6	Week 11-12: Demonstration Experiment -1, Demonstration Experiment -2 & Assessment -02	Implementing real-time/technical applications using File handling Assessment-02 to be scheduled after the completion of all experiments.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture/Demonstration	Utilize various teaching methods to explain concepts and demonstrates code examples.
2	Practice-based Learning	Focus on coding practice through exercises, challenges, and projects to solidify understanding.
3	Break down Complex Topics	Present complex topics in smaller, manageable steps with clear explanations.
4	Code Reviews and Pair Programming	Students review each other's code and collaborate on coding tasks, fostering peer learning.
5	Practice-based Learning (PBL)	Focus on coding practice through exercises, challenges, and projects to solidify understanding.
6	Assessment and Reflection	Regularly assess progress through quizzes, assignments, and code reviews to identify areas for improvement andencourage reflection on learning processes.
7	Real-world Examples	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)

Internal test for laboratory course with software experiments shall be conducted for a total of 100 marks at the end the semester and the assessment pattern.

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

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

1. SEE marks for practical course shall be 50 marks

Marks distribution for Experiment based Practical Course for Final CIE

2. SL. No.	3. Description	4. % of Marks	5. Marks
6. 1	7. Write-up, Procedure	8. 20%	9. 20
10. 2	11. Conduction and result	12. 60%	13. 60
14. 3	15. Viva-Voce	16. 20%	17. 20
18. Total		**19. 100%**	**20. 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	Core Python Reinforcement	Students will Solidify their understanding of functions, data structures(lists, tuples, dictionaries, sets), and object-oriented programming (OOP) principles. Write more efficient and maintainable code.
2	Data Structures& Algorithms	Students will learn to explore advanced data structures like stacks, queues, trees, and graphs and they will be able to earn to choose the right data structure for different tasks, making your code more efficient.
3	NumPy for Numerical Computing	Students will Gain the ability to handle numerical data efficiently using NumPy. Solve problems in science, engineering, and data analysis.
4	Project-Based Learning	Students will Work on real-world or simulated projects throughout the course (if offered). Apply your Python knowledge to solve problems and develop applications. Gain practical experience and enhance your portfolio (if applicable).
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
M23BEM309A.1	Apply advanced string manipulation techniques and data structures to solve complex problems
M23BEM309A.2	Design and implement solutions using NumPy library functionalities for numerical computations and matrix operations.
M23BEM309A.3	Develop object-oriented programs using Turtle graphics library for data visualization and user interaction.

CO-PO-PSO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BEM309A.1	-	-	-	-	-	-	**3**	-	-	-	-	-	**3**	-
M23BEM309A.2	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BEM309A.3	-	-	-	-	-	-	-	-	-	**3**	-	-	**3**	-
M23BEM309A	**3**	-	-	-	-	-	**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

Python's versatility and focus on clear code make it a perfect language for mechanical engineersto enhance their skillset and tackle complex problems. Here's how advanced Python skills will empower you in the future:

1. **Data Acquisition and Analysis:**
   - ✓ **Sensor Data Processing:** Leverage Python's libraries (like Pandas) to clean, analyze, andvisualize sensor data from experiments, simulations, and real-world applications (e.g., wind turbine sensor data).
   - ✓ **Signal Processing:** Analyze and manipulate signals (vibrations, pressure) using libraries like SciPy to gain insights into machine behavior and optimize performance.
2. **Machine Learning for Mechanical Engineering:**
   - ✓ **Predictive Maintenance:** Develop Python models (using scikit-learn) to predict equipment failures and schedule maintenance proactively, reducing downtime and costs.
   - ✓ **Design Optimization:** Utilize machine learning algorithms to analyze vast datasets and optimize designs for parameters like strength, weight, and efficiency.
3. **Computational Mechanics and Simulations:**
   - ✓ **Finite Element Analysis (FEA):** Python can be used to pre-process and post-process data from FEA simulations, allowing you to analyze stress, strain, and deformation in mechanical systems.
   - ✓ **Computational Fluid Dynamics (CFD):** Libraries like OpenFOAM (utilizing Python scripting) enable you to simulate fluid flow around objects, aiding in aerodynamic and hydrodynamic design optimization.
4. **Automation and Robotics:**
   - ✓ **Robot Control and Automation:** Leverage Python to control robots and automate tasks in manufacturing or testing environments (e.g., robotic arm control for automated assembly).
   - ✓ **Data Acquisition from Robots:** Develop Python scripts to capture data from robot sensors for analysis and performance monitoring.
5. **3D Printing and Additive Manufacturing:**
   - ✓ **Slicing and G-code Generation:** Utilize Python to slice 3D models for printing and generate G-code instructions for 3D printers, allowing for customization and automation of the 3D printing process.
   - ✓ **Design Optimization for Additive Manufacturing:** Python can be used to optimize designs for additive manufacturing, considering factors like support structures and material usage.

3rd Semester	Ability Enhancement Course (AE) INTRODUCTION TO VIRTUAL REALITY	M23BEM309B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Basic Computer Skills	Knowledge of basic computer operations. Familiarity with using a computer, operating systems (Windows, macOS, Linux), and basic troubleshooting.
2	Basic programming knowledge	Knowledge on basic programming languages like C, C++. Understanding of basic programming constructs such as variables, loops, conditionals, and functions.
3	Mathematics	Knowledge on algebra, geometry and trigonometry. Understanding of algebraic concepts, as they are often used in game development and VR programming. Knowledge of geometric principles, particularly those related to 3D space, which is crucial for VR environments. Basic trigonometric functions and their applications in 3D transformations and rotations.
4	Computer Graphics Basics	Fundamentals of computer graphics Understanding of how computer graphics work.
5	Logic Circuit Analysis	Ability to analyze and design logic circuits, including combinational and sequential circuits
6	Basics of hardware	Knowledge about VR hardware. Familiarity with VR headsets.

2. Competencies

S/L	Competency	KSA Description
1	**Understanding the basic principles and definitions of VR**	**Knowledge:** Understanding VR, including its key components like immersion, interactivity, and presence. **Skills:** Ability to accurately describe and differentiate VR from related technologies such as augmented reality (AR) and mixed reality (MR) **Attitudes:** Openness towards exploring new and emerging VR technologies and their potential applications across various fields.
2	**Knowledge of the historical milestones in VR development**	**Knowledge:** Understanding the key historical milestones in VR development. **Skills:** Ability to critically analyze the progression and impact of VR technologies over time, and apply this understanding to evaluate current and future VR trends **Attitudes:** Open-minded and forward-thinking attitude towards new VR technologies and innovations.
3	**Familiarity with human sensory systems and their relevance to VR**	**Knowledge:** Understanding the structure and function of human sensory systems, including vision, hearing, touch, and proprioception, and their significance in creating immersive VR experiences. **Skills:** Design and developing VR applications that effectively engage multiple sensory modalities to create realistic and immersive environments. **Attitudes:** Maintaining a user-centric approach that prioritizes the comfort and engagement of users.
4	**Identification of key elements that make up a VR**	**Knowledge:** Understanding the core components of a VR experience, including hardware (headsets, controllers, sensors), software (applications, platforms), and content (3D models, environments, interactions).

	experience	**Skills:** Ability to design and integrate VR elements effectively, ensuring seamless interaction between hardware, software, and content. **Attitudes:** Detail-oriented and innovative mindset towards the development of VR experiences.
5	**Understanding the components and workings of VR systems**	**Knowledge:** Understanding the various components of VR systems, including hardware (headsets, motion trackers, input devices), software (VR engines, development platforms), and networking (data transmission, latency issues). **Skills:** Proficiency in setting up, configuring, and maintaining VR systems. **Attitudes:** Adaptability to new technologies and methodologies in VR.
6	**Awareness of various input and output devices used in VR**	**Knowledge:** Understanding the range of input devices (e.g., motion controllers, gloves, eye trackers) and output devices (e.g., VR headsets, haptic feedback systems, and auditory systems) used in VR. **Skills:** Ability to select, set up, and integrate appropriate input and output devices for specific VR applications **Attitudes:** User-focused attitude towards adopting and experimenting with new VR input and output devices.
7	**Knowledge of diverse applications of VR technology**	**Knowledge:** Understanding the wide range of applications for VR technology, including gaming, education, healthcare, training simulations, real estate, and social interactions. **Skills:** Ability to design and implement VR solutions tailored to specific applications, leveraging the strengths of VR to address industry-specific needs. **Attitudes:** Open-minded attitude towards exploring new and innovative uses for VR technology.

3. Syllabus

INTRODUCTION TO VIRTUAL REALITY SEMESTER – III			
Course Code	**M23BME309B**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:2:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**30 hours Theory**	Total Marks	**100**
Credits	**01**	Exam Hours	**01**
Course objectives: • Describe how VR systems work and list the applications of VR. • Understand the design and implementation of the hardware that enables VR systems to be built. • Understand the system of human vision and its implication on perception and rendering. • Explain the concepts of motion and tracking in VR systems. • Describe the importance of interaction and audio in VR systems.			
Module -1			
Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.			
Module -2			
Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR			
Module -3			
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR			
Module -4			

Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information. Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.
Module -5
Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection. Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies.
Text Books: 1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016 2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002. 3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009. **Reference Books:** 1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005. 2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005. 3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005. 4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: **Introduction to Virtual Reality**	Introduction virtual reality, Defining Virtual Reality, History of VR Human Physiology and Perception Key Elements of Virtual Reality Experience, Virtual Reality System Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.
2	Week 3-4: **Representing the Virtual World**	Representation of the Virtual World Visual Representation, Aural Representation, Haptic Representation in VR
3	Week 5-6: **The Geometry of Virtual Worlds &The Physiology of Human Vision**	Introduction to Geometric Models Changing Position and Orientation, Axis-Angle Representations of Rotation Viewing Transformations, Chaining the Transformations Human Eye, eye movements & implications for VR
4	Week 7-8: **Visual Perception & Rendering**	Perception of Depth, Perception of Motion, Perception of Color Combining Sources of Information Visual Rendering -Ray , Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.
5	Week 9-10: **Motion & Tracking**	Motion in Real and Virtual Worlds- Velocities and Accelerations The Vestibular System, Physics in the Virtual World Mismatched Motion and Vection. Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation Tracking Attached Bodies.
6	Week 11-12:	Assignments and group discussions.

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 virtual reality concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher Order	Pose HOTS questions to stimulate critical thinking related to each competency.

	Thinking (HOTS) Questions	
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)

Final CIE for Theory based Ability Enhancement Course

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 (A+B)			**50**	**20**

1. The CIE question paper shall have MCQ set for 25 questions, each carrying one mark.
2. 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 basic principles of VR	Students grasp the fundamental concepts and technologies that create immersive, interactive, and simulated environments.
2	Components of a virtual reality system	Students will able to identify and explain the key hardware and software elements that work together to create an immersive VR experience, including headsets, motion sensors, input devices, and VR software.
3	Concepts related to virtual reality	Students will learn the theoretical and practical aspects of VR, including immersion, presence, interactivity, and the sensory feedback mechanisms that enhance the user experience
4	Types of virtual reality experiences	Students will explore and differentiate various VR applications, such as fully immersive, non-immersive, and augmented reality, and their respective uses in fields like gaming, education, training, and simulation
5	Virtual reality across different industries	Students will explore the diverse applications of virtual reality (VR) across industries such as healthcare, education, entertainment, manufacturing, and architecture, to understand its transformative potential and future implications.

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

Course Outcomes (COs)

COs	Description
M23BME309B.1	Understand the fundamental concepts and history of virtual reality, including its defining characteristics, historical development, and applications across various industries.
M23BME309B.2	Analyze the key elements of a virtual reality system, including input and output interfaces such as visual, aural, and haptic displays.
M23BME309B.3	Understand the physiology of human vision to manipulate virtual environments effectively by applying geometric models knowledge.
M23BME309B.4	Understand the concepts of visual perception principles, including depth, motion, and color perception, as well as rendering techniques.
M23BME309B.5	Applying the concepts of motion principles and tracking techniques to enhance virtual reality experiences.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME309B.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309B.2	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME309B.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309B.4	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309B.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME309B	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**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 future of virtual reality in engineering education is exciting, offering new ways for students to learn, collaborate, and innovate in the field. As VR technology continues to advance, it is likely to become an integral part of the curriculum for engineering students, providing them with valuable skills and knowledge for their future careers. Here are some notable contributions:

- **Simulation and Training:** VR can be used to simulate complex mechanical systems and environments, allowing students to visualize and interact with them in a virtual space. This can be particularly useful for training in maintenance, repair, and operation of machinery and equipment.
- **Product design and protoyping:** Mechanical engineering students can use VR to design and prototype products in a virtual environment, enabling them to test and optimize their designs before creating physical prototypes. This can help reduce costs and speed up the product development process.
- **Digital Twin Technology**: VR can be integrated with digital twin technology, creating virtual replicas of physical machines or systems. This allows students to monitor and analyze the performance of these systems in real-time, leading to better understanding and optimization of mechanical processes.
- **Collaborative Design and Engineering**: VR enables students to collaborate on design and engineering projects in a virtual environment, regardless of their physical location. This promotes teamwork and allows for more efficient and effective collaboration among students.
- **Data Visualization and Analysis**: VR can help students visualize and analyze large datasets related to mechanical systems, such as stress analysis, fluid dynamics, and thermal simulations. This can lead to deeper insights and better decision-making in mechanical engineering projects.
- **Remote Maintenance and Monitoring**: With VR, students can remotely access and monitor mechanical systems in real-time, allowing for faster response times and reduced downtime. This can be particularly beneficial for industries where machinery is located in remote or hazardous environments.
- **Augmented Reality (AR) Integration**: The integration of AR with VR can further enhance the learning experience for mechanical engineering students. AR overlays digital information onto the physical world, allowing students to interact with virtual objects in a real-world context.

3rd Semester	Ability Enhancement Course (AE) SPREAD SHEET FOR ENGINEERS	M23BEM309C

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 engineering data**	**Knowledge:** Trendline concepts (slope, intercept) Interpolation and forecasting using trendlines 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	**M23BME309C**	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:
1. Create informative visualizations with error bars for engineering data.
2. Perform essential data analysis calculations relevant to engineering.
3. Utilize conditional formatting and formulas for data-driven decision making in engineering.
4. Develop and interpret regression models to analyze engineering data.

5. Implement iterative solutions for engineering problems using Excel's Goal Seek and Solver tools. 6. 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 Runge Kutta Method, Solving a Second Order Differential Equation
Resources: Excel Resources - 600+ Self Study Guides, Articles & Tools (wallstreetmojo.com) McFedries PaulMicrosoft 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)

Internal test for laboratory course with software experiments shall be conducted for a total of 100 marks at the end the semester and the assessment pattern.

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

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

SEE marks for practical course shall be 50 marks

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**

1. See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
2. Change of experiment/program is allowed only once and 20% marks allotted to the procedure/write-up part to be made zero.
3. Duration of SEE shall be 3 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 formulas for data-driven decisions	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 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
M23BME309C.1	Illustrate advanced proficiency in Excel, mastering data analysis and visualization through creating XY scatter graphs, Functions, Regression Analysis
M23BME309C.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.
M23BME309C.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
M23BME309C.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309C.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309C.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME309C	**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. Civil engineers might have features for analysing structural loads, while mechanical engineers could get tools for simulating machine performance. 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.

3rd Semester	Non-Credit Mandatory Course (NCMC) NATIONAL SERVICE SCHEME (NSS)	M23BNSK310

National Service Scheme (NSS)			
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.

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.

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 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:

Cos	Description
M23BNSK310.1	**Understand** the importance of his / her responsibilities towards society.
M23BNSK310.2	**Analyze** 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 national 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	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

			officers / campus etc…		evaluation authority	
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
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	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

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	**Sectorwise 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 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** –	• Implementation strategies of the

	100%	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.
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**	
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) YOGA	M23BYOK310

Yoga			
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-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 substance abuse (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
  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, 2 rounds
- 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.
- Different types of Asanas
  a. Sitting
     1. Sukhasana
     2. Paschimottanasana
  b. Standing
     1. Ardhakati Chakrasana
     2. Parshva Chakrasana
  c. Prone line
     1. Dhanurasana
  d. Supine line
     1. Halasana
     2. Karna Peedasana
- Meaning, importance and benefits of Kapalabhati.
- 40 strokes/min 3 rounds
- Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama.
- Pranayama
  1. Suryanuloma –Viloma
  2. Chandranuloma-Viloma
  3. Suryabhedana
  4. Chandra Bhedana
  5. Nadishodhana

Semester V

- Patanjali'sAshtanga Yoga its need and importance.
- Ashtanga Yoga
  1. Asana
  2. Pranayama
  3. Pratyahara
- Asana its meaning by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas
  a. Sitting 1. Ardha Ushtrasana 2. Vakrasana 3. Yogamudra in Padmasana
  b. Standing 1. UrdhvaHastothanasana 2. Hastapadasana 3. ParivrittaTrikonasana 4. Utkatasana
  c. Prone line 1. Padangushtha Dhanurasana 2. Poorna Bhujangasana / Rajakapotasana
  d. Supine line 1. Sarvangasana 2. Chakraasana 3. Navasana/Noukasana 4. Pavanamuktasana
- Revision of practice 60 strokes/min 3 rounds

- Meaning by name, technique, precautionary measures and benefits of each Pranayama 1. Ujjayi 2. Sheetali 3. Sheektari

Semester VI

- Ashtanga Yoga
  1. Dharana
  2. Dhyana (Meditation)
  3. Samadhi
- Asana by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas
  a. Sitting 1. Bakasana 2. Hanumanasana 3. Ekapada Rajakapotasana 4. Yogamudra in Vajrasana
  b. Standing 1. Vatayanasana 2. Garudasana
  c. Balancing 1. Veerabhadrasana 2. Sheershasana
  d. Supine line 1. Sarvangasana 2. Setubandha Sarvangasana 3. Shavasanaa (Relaxation poisture).
- Revision of Kapalabhati practice 80 strokes/min - 3 rounds
- Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama 1. Bhastrika 2. Bhramari
- Meaning, Need, importance of Shatkriya.
- Different types. Meaning by name, technique, precautionary measures and benefits of each Kriya 1. Jalaneti & sutraneti 2. Nouli (only for men) 3. Sheetkarma Kapalabhati

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

6. https://youtu.be/KB-TYlgd1wE
7. https://youtu.be/aa-TG0Wg1Ls

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

Semester - III			
PHYSICAL EDUCATION (SPORTS & ATHLETICS) — I			
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

CO1. Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness.
CO2. Familiarization of health-related Exercises, Sports for overall growth and development.
CO3. Create a foundation for the professionals in Physical Education and Sports.
CO4. Participate in the competition at regional/state / national / international levels.
CO5. Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.

Module-1

Orientation:(5 hours)

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

Module-2

General Fitness & Components of Fitness: (15 hours)

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: (10 hours)

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**

Semester - IV
PHYSICAL EDUCATION (SPORTS & ATHLETICS) — II

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)

A. Ethics in Sports
B. Moral Values in Sports and Games

Module-2
Specific Games (Any one to be selected by the student): (20 hours) A. Volleyball — Attack, Block, Service, Upper Hand Pass and Lower hand Pass. B. Throwball — Service, Receive, Spin attack, Net Drop & Jump throw. C. Kabaddi — Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. D. Kho-Kho — Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. E. Table Tennis — Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. F. Athletics (Track / Field Events) — Any event as per availability of Ground.
Module-3
Role of Organization 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**

3rd Semester	Basic Science Course (BSC) 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 ordertwo-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 andCross 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

Text Books

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2015.
2. Advanced Engineering Mathematics, E. Kreyszig John, Wiley & Sons, 10th Edition, 2015.
3. Engineering Mathematics, N. P. Bali and Manish Goyal, Laxmi Publishers, 7th Edition, 2007.
4. Higher Engineering Mathematics, H. K. Das and Er. Rajnish Verma, S. Chand & Company

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 irrotational 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 format to reinforce Competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance Understanding of mathematics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Higher OrderThinking (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-WorldApplication	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)

7. Learning Objectives

S/L	Learning Objectives	Description
1	UnderstandingIntegral 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, andsolve 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
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						
Module 2						
Module 3						
Module 4						
Module 5						
Total						**50**

Semester End Examination (SEE)

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

Conditions for SEE Paper Setting:

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

10. Future with this Subject

The Additional Mathematics-I 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:

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.

3rd Semester	AICTE ACTIVITY POINT PROGRAM	

AICTE Activity Point Program
(Ref.: Chapter – 6 – AICTE Internship Policy – Guidelines & Procedures)

Ref. No.: VTU/BGM/ACA-OS/GEN-CIRS/2019-20/3014 dated 01/08/2019

Preamble:
Apart from technical knowledge and skills, students should have excellent soft skills, leadership qualities, and team spirit to be successful as professionals. They should have entrepreneurial capabilities and societal commitment. In order to match this multifarious requirement, AICTE has created a unique mechanism for awarding Activity Points over and above academic grades.

1. Every student admitted to the 4-year Degree program and entering the 4-year Degree program through lateral entry shall earn 100 and 75 Activity Points, respectively, for the degree award through the AICTE Activity Point Program. Students transferred from other Universities to the fifth semester must earn 50 Activity Points from the year of entry to VTU.
2. The Activity Points earned shall be reflected on the student's eighth-semester Grade Card.
3. The activities can be spread over the years (duration of the program), anytime during the semester, weekends, and holidays, as per the interest and convenience of the student from the year of entry to the program. However, the minimum hours specified must be satisfied.
4. Activity Points (non-credit) do not affect SGPA/CGPA and shall not be considered for vertical progression.
5. If a student fails to earn the prescribed Activity Points, the Eighth semester Grade Card shall be issued only after earning the required Activity Points. Students shall be admitted for the award of the degree only after the release of the Eighth semester Grade Card.
6. For more details, refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines.
7. Submission of Activity Points: The consolidated report of activity points earned by the students shall be sent to the Controller of Examinations. Dean-Academics will issue a notification in this respect.

Sl. No.	Student Category	Activity Points prescribed by AICTE
1.	Day College regular student admitted to the four-year Degree program (Admitted during 2022-23)	100
2.	A student entering the four-year Degree program through lateral entry (Admitted during 2022-23)	75
3.	Students transferred from other Universities to the fifth semester (Admitted during 2022-23)	50

AICTE Activity Point Programme (Activity Summary Sheet)

The AlCTE Activity Program, a non-credit program, can be taken up at any time during the semester, on weekends, and on holidays. These activities can be spread over the years at the student's convenience. However, the minimum hours specified must be satisfied.

Students in teams of their choice may carry out the following suggestive activities.

Sl. No.	Activity Head	Minimum Duration		Performance Appraisal/ Maximum Point/ Activity	Evaluated by
		Weeks	Hours		
1.	Helping local schools to achieve good results and enhance their enrolment in Higher/Technical/ Vocational Education.	2	80-90	20	NSS/Youth Red Cross Coordinators /Chairperson-CICC (College Internal Complaints Committee) / SAGY (Sansad Adarsh Gram Yojana, GovL of India) of the institute/ Mentor
2.	Preparing an actionable business proposal to enhance the village's income.	2	80-90	20	
3.	Developing a Sustainable Water Management system	2	80-90	20	
4.	Tourism Promotion Innovative Approaches.	2	80-90	20	
5.	Promotion of Appropriate Technologies.	2	80-90	20	
6.	Reduction in Energy Consumption.	2	80-90	20	
7.	To Skill rural population.	2	80-90	20	
8.	Facilitating 100% Digitized money transactions.	2	80-90	20	
9.	The setting of the information-imparting club for	2	80-90	20	

	women leads to contributions to social and economic issues.				
10.	Developing and managing an efficient garbage disposable system.	2	80-90	20	
11.	To assist in the marketing of rural produce.	2	80-90	20	
12.	Food preservation/packaging.	2	80-90	20	
13.	Automation of local activities.	2	80-90	20	
14.	Spreading public awareness under rural outreach program.	2	80-90	20	
15.	Contribution to any national-level initiative of the Government of India. E.g., Digital India/ Skill India/ Swachh Bharat Internship, etc.	2	80-90	20	
16.	Creating an awareness regarding rainwater harvesting in urban and rural areas.	2	80-90	20	

4th Semester

4th Semester	Basic Science Course (BSC) 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 Structure and 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 life processes.
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 life processes.
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-Bioinspired Materials and Mechanisms**	**Knowledge:** • Comprehend the principles behind bioinspired 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 behind bioengineering. **Skills:** • Analyze and apply knowledge of bioengineering principles to understand various environmental and industrial contexts. **Attitudes:** • Demonstrate curiosity about how natural systems work and their potential applications. • Exhibit a proactive approach to learning from nature to solve engineering challenges.

3. Syllabus

BIOLOGY FOR ENGINEERS **SEMESTER – III/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 natural systems.
- 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 Bioplastics, 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 Perfluorocarbons (Pfcs).	L1, L2, L3
MODULE 5 (3 Hours)	
TRENDS IN BIOENGINEERING: Scaffolds In Muscular, Skeletal Systems and Tissue Engineering, Bioprinting Techniques and Materials. Electrical Tongue and Electrical Nose in Food Science, DNA Origami and Biocomputing, Bioimaging, and Artificial Intelligence for Disease Diagnosis. Bioconcrete. Bioremediation. Biomining.	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 GeethaA 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.

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 and their Applications	**Competency:** Apply knowledge of biomolecules to real-world applications **Knowledge:** Understand the properties and functions of key biomolecules: 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 as a 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-Bioinspired Materials and Mechanisms	**Competency:** Utilize bioinspired materials and mechanisms. **Knowledge:** Understand and explain natural bio-inspired mechanisms. **Skills:** Apply knowledge of natural principles to design innovative materials and systems.
5	Week 11-12: Trends in Bioengineering	**Competency:** Keep abreast of current trends and technologies in bioengineering. **Knowledge:** Understand the principles and applications of various bioengineering 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	**Collaborative Learning**	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 application of 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)

Final CIE for Theory based Ability Enhancement Course

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 (A+B)			**50**	**20**

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

Semester End Examination

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 application of 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	Bioinspired 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/ PSOs

Course Outcomes (COs)

COs	Description
M23BBIOK401.1	Elucidate the fundamentals of biological concepts employing pertinent health, and engineering 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 biomimetics perceptions for explicit engineering solutions.
M23BBIOK401.4	Exploring innovative biobased solutions for relevant biological complications.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M23BBIOK401.1	**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**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

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

Conditions for SEE Paper Setting:

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

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

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

4th Semester	Integrated Professional Course (IPC) APPLIED THERMODYNAMICS	M23BME402

1. Prerequisites

S/L	Proficiency	Prerequisites
6.	Basic Thermodynamics	To excel in applied thermodynamics, students need to understand thermodynamic systems and properties, including open, closed, and isolated systems, as well as state properties like pressure, volume, temperature, and specific heats. They should be able to apply laws of thermodynamics, encompassing concepts of internal energy, work, heat, and energy conservation, covering entropy, irreversibility, and the Carnot cycle. Additionally, proficiency in analyzing thermodynamic processes (isothermal, adiabatic, isobaric, and isochoric) and fundamental cycles such as Carnot and Rankine is essential.
7.	Understanding of Physical Quantities and Units	Students should be comfortable with concepts like mass, length, time, temperature, pressure, and be able to work with different unit systems (SI units are preferred).
8.	Mathematical Problem Solving	Familiarity with differentiation and integration will be advantageous. Calculus helps understand how properties change with respect to other variables.
9.	Problem-Solving Skills	The ability to use learned concepts and equations to solve numerical problems by applying their knowledge to various scenarios.
10.	Physics Fundamentals	Students need a strong grasp of Newtonian mechanics, including the concepts of force, motion, and energy. They should understand the principles of work and energy, as well as power and efficiency. A basic understanding of heat transfer, temperature scales, and the properties of matter is an added advantage.
11.	Chemistry Fundamentals	Students should be familiar with the basic structure of atoms, molecules, and ions. They must understand chemical reactions, including stoichiometry and conservation of mass. Knowledge of the ideal gas law and other gas laws, as well as phase changes and basic thermodynamic quantities such as enthalpy and entropy, is an added advantage.

2. Competencies

S/L	Competency	KSA Description
1	**Air standard cycles**	**Knowledge:** Detailed processes in Carnot, Otto, Diesel, and Dual cycles. P-V and T-S diagrams for each cycle. Efficiency and performance metrics of each cycle **Skills:** Derive and calculate thermal efficiency, mean effective pressure, work done, and heat transfer for each cycle. **Attitudes:** Appreciation for the importance of thermodynamic cycles in engineering and real-world applications.
2	**IC engines**	**Knowledge:** Understand the fundamental principles, components and performance parameters of internal combustion engines. **Skills:** Calculate and analyze engine performance parameters. **Attitudes:** Appreciate the importance of accurate performance measurement in engine development and optimization.
3	**Gas power cycles**	**Knowledge:** Understand the fundamental principles and processes of gas power cycles **Skills:** Develop the ability to analyze cycle performance, design components, and assess system efficiency. **Attitudes:** Appreciation for the significance of gas power cycles , power generation and transportation.
4	**Vapour**	**Knowledge:**

	power cycles	Understand the fundamental principles and components of vapor power cycles, including Rankine and reheat-regenerative cycles. **Skills:** Develop the ability to analyze cycle performance, design components, and evaluate system efficiency. **Attitudes:** Appreciate the significance of vapor power cycles in power generation, energy conversion, and environmental sustainability
5	**Refrigeration cycles and air conditioning**	**Knowledge:** Understand the fundamental principles and components of refrigeration cycles and air conditioning systems. **Skills:** Develop the ability to analyze system performance, design components, and assess system efficiency. **Attitudes:** appreciation for the significance of refrigeration and air conditioning in maintaining comfort, preserving perishables, and enhancing quality of life, as well as the importance of energy efficiency and environmental sustainability in these fields.
6	**Reciprocating Compressors**	**Knowledge:** Understand the fundamental principles and working mechanisms of reciprocating compressors. **Skills:** Develop the ability to analyze the performance of reciprocating compressors, design and evaluate their efficiency. **Attitudes:** Appreciation for the importance of reciprocating compressors and in energy conversion processes and industrial applications.

3. Syllabus

APPLIED THERMODYNAMICS SEMESTER – IV			
Course Code	M23BME402	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 + 12 Laboratory session	Total Marks	**100**
Credits	04	Exam Hours	**03**

Course objectives: This course will enable students to:

- Apply the concept of thermodynamic cycle to evaluate the performance of air standard cycles and gas power cycle.
- Understand the significance of phase diagrams with respect to working of steam power plants and evaluate the performance of steam power cycles and methods improve their efficiency.
- Understand combustion phenomenon and to evaluate the performance parameters in I C Engines.
- Determine performance parameters of refrigeration and air-conditioning systems.
- Evaluate the performance parameters of reciprocating air compressor.

Module -1	
Air standard cycles: Carnot cycle. Otto, Diesel, Dual and cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.	L1, L2, L3
Module -2	
I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, Heat balance, Morse test **Gas power Cycles: Gas turbine (Brayton) cycle;** description and analysis. Regenerative, Intercooling and reheating in gas turbine cycles.	L1, L2, L3
Module -3	
Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. **Actual vapour power cycles:** Actual vapour power cycles, regenerative vapour power cycle with open and closed feed water heaters. Reheat Rankine cycle.	L1, L2, L3
Module -4	

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system. **Pscychrometrics and Air-conditioning Systems:** Psychometric properties of Air (only for review), Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.	L1, L2, L3
Module -5	
Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.	L1, L2, L3
PRACTICAL COMPONENT Using suitable simulation software, demonstrate the operation of the following circuits:	
1.	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus..
2.	Determination of Calorific value of solid, liquid and gaseous fuels.
3.	Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4.	Valve Timing/port opening diagram of an I.C. Engine.
5.	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine Variable Compression Ratio I.C. Engine.
6.	Measurements of Exhaust Emissions
Text Books: 1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill, 6th Edition 2018 2. Thermodynamics, Yunus A, Cengel, Michael A Boles, Tata McGraw Hill 7th Edition **Reference Books:** 1. Thermodynamics for engineers Kenneth A. Kroos and Merle C. Potter, Cengage Learning 2016 2. Principles of Engineering Thermodynamics, Michael J, Moran,Howard N. Shapiro, Wiley 8th Edition 3. I.C.Engines, M.L.Mathur&Sharma. Dhanpat Rai& sons-India	

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Air standard cycles	Importance of studying the subject, application areas are discussed in detail. Deriving efficiency equation for all air standard cycles and solving numerical.
2	Week 3-4: Performance of IC engines	Discussing performance parameters of IC engines and solving numerical on the same.
3	Week 5-6: Gas power cycles	Examination of gas turbines, encompassing theoretical cycles and methods for enhancing efficiency. Exploring various techniques such as intercooling, reheating and regeneration into optimizing turbine performance and solving numerical on the same.
4	Week 7-8: Vapour power cycles	Theoretical and practical Rankine cycle analysis will be conducted, and numerical problems pertaining to efficiency-enhancing strategies such as reheat-regenerative cycles will be resolved.
5	Week 9-10: Refrigeration cycles and Psychrommetry	Vapor compression refrigeration systems, PH chart interpretation, psychometric, and practical air conditioning applications, alongside solving numerical problems.
6	Week 11-12:, Air compressors	Air compressor cycle efficiency and multi stage compressors; numerical problems pertaining efficiency to be 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 thermodynamics concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
5	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of 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

6. Assessment Details (both CIE and SEE)

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 Examination

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. 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	Air standard cycles and performance of IC engines	Apply the concept of thermodynamic cycle to evaluate the performance of air standard cycles. Understand combustion phenomenon and evaluate the performance parameters in I C Engines.
2	Gas power cycles	Apply the concept of thermodynamic cycle to evaluate the performance of gas power cycles.
3	Vapour power cycles	Understand the significance of phase diagrams with respect to working of steam power plants and evaluate the performance of steam power cycles and methods improve their efficiency.
4	Refrigeration cycles and psychrommetry	Determine performance parameters of refrigeration and air-conditioning systems.
5	Air compressors and steam nozzles	Evaluate the performance parameters of reciprocating air compressor.

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

Course Outcomes (COs)

COs	Description
M23BME402.1	Apply the concept of thermodynamic cycle to evaluate the performance of air standard cycles.
M23BME402.2	Assess the performance parameters of IC Engines and gas power cycles
M23BME402.3	Evaluate the performance of steam power cycles and methods improve their efficiency and interpret phase diagrams with respect to working of steam power plants.
M23BME402.4	Analyze performance parameters of refrigeration and air-conditioning systems.
M23BME402.5	Analyze the performance parameters of reciprocating air compressor.
M23BME402.6	Conduct performance and emission tests on internal combustion engines and assess

	fluid properties using test rigs.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME402.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME402.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME402.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME402.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME402.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME402.6	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME402	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**CO6**	**Total**
Module 1	**5**						**5**
Module 2		**5**					**5**
Module 3			**5**				**5**
Module 4				**5**			**5**
Module 5					**5**		**5**
Lab Component						**25**	**25**
Total	**10**	**10**	**10**	**10**	**10**	**25**	**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 "Applied thermodynamics" 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 Thermal Engineering. Here are some notable contributions:

Heat transfer: Since thermodynamics offers the fundamental ideas and concepts needed to comprehend how heat energy behaves and moves in various systems, it is a prerequisite for studying heat transfer. Without a solid grounding in thermodynamics, it would be challenging to accurately study and apply heat transfer principles in practical engineering and scientific contexts.

Energy Engineering: Thermodynamics equips energy engineers with the necessary knowledge to develop and improve sustainable and efficient energy solutions while minimizing environmental impact. Thermodynamics is a prerequisite for studying energy engineering because it provides essential principles of energy conservation, conversion, and efficiency, which are fundamental for analyzing and optimizing energy systems. It introduces key concepts such as the first and second laws of thermodynamics, thermodynamic cycles, properties of working fluids, and exergy analysis. These principles are crucial for designing efficient power generation, refrigeration, and renewable energy systems, understanding combustion and fuel efficiency, and managing heat transfer and energy storage.

Project Work and Research: Studying applied thermodynamics is crucial for both advanced thermal engineering courses and undergraduate projects, as it provides fundamental principles of energy conservation, conversion, and efficiency. This knowledge is essential for designing and analyzing systems like heat exchangers, HVAC systems, and renewable energy solutions. It also aids in conducting experiments and solving real-world engineering problems, making it indispensable for practical engineering education.

Industry Applications: Studying applied thermodynamics is vital for industry applications as it underpins the design and optimization of energy systems like power plants, HVAC systems, and refrigeration units. It ensures efficient energy conversion and utilization in processes such as combustion, heat exchange, and renewable energy generation. This foundational knowledge is essential for developing sustainable solutions, improving system efficiencies, and minimizing environmental impact in various industrial sectors.

4th Semester	Professional Core Course (PCC) MACHINING SCIENCE & METROLOGY	M23BME403

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Mathematics (Trigonometry)	Strong skills in trigonometry are necessary for calculations involving cutting angles, tool geometry, and machining parameters.
2.	Physics	Concepts of motion, energy, and power are fundamental to machining science. Understanding these principles allows you to analyze cutting forces, power requirements, and heat generation during machining
3.	Material Science	Knowledge of the properties of different materials (metals, plastics, ceramics) being machined is essential. This includes their mechanical properties, machinability characteristics.
4.	Manufacturing Processes	A foundational understanding of various manufacturing processes, especially machining processes like turning, milling, drilling, grinding etc.
5.	Workshop Skills	Prior experience with basic workshop tools and practices can be advantageous
6.	Technical Drawing	The ability to interpret technical drawings can be beneficial. These skills can help visualize machining processes, understand tool paths.

2. Competencies

S/L	Competency	KSA Description
1.	Metal cutting processes	**Knowledge:** Principles of mechanics (forces, stresses), Fundamentals of machining processes **Skills:** Analyze cutting mechanisms and tool characteristics. Apply mathematical concepts to metal cutting calculations. Interpret graphical representations (Merchant circle diagram). Solve numerical problems with accuracy. **Attitudes:** Analytical thinking - Problem-solving - Attention to detail.
2.	Machine parts, functions and operations.	**Knowledge:** Functionalities of various machining tools & Metal cutting principles, Basic engineering drawing (helpful) **Skills:** Operate lathe, milling, shaping, drilling, and grinding machines safely and efficiently. Identify common machining problems and troubleshoot solutions. **Attitudes:** Safety consciousness - Attention to detail - Adaptability - Initiative
3.	Cutting fluids.	**Knowledge:** Importance of cutting fluids in machining and cutting tool materials. **Skills:** Select appropriate cutting fluids for specific machining processes. Apply cutting fluids safely and effectively. **Attitudes:** Safety awareness - Observational skills - Critical thinking - Attention to detail
4.	Metrology, Measurements & Standards	**Knowledge:** Principles of measurement - Standards of measurement **Skills:** Utilize measuring instruments (calipers, micrometers) for accurate measurements **Attitudes:** Precision and accuracy - Observational skills - Critical thinking - Attention to detail
5.	Tolerance, Limits & Fits	**Knowledge:** Importance of tolerance in assembly processes **Skills:** Analyze tolerance requirements for different assembly applications. **Attitudes:** Quality consciousness - Attention to detail - Problem-solving skills - Analytical thinking
6.	Gauges &	**Knowledge:**

	Taylor's principle	Functionality and types of gauges, Principles of gauging and inspection. **Skills:** Select appropriate gauges for specific inspection tasks **Attitudes:** Quality consciousness - Attention to detail - Technical skills - Analytical thinking - Initiative

3. Syllabus

MACHINING SCIENCE & METROLOGY SEMESTER – IV			
Course Code	**M23BME403**	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**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To understand the basic principles of measurements and angular measurement.
- To enrich the knowledge pertaining to gauge

Module -1

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Simple Numerical problems.
Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, various operations carried out on lathe. Turret and Capstan lathe.

Module -2

Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), various milling operations.
Shaping Machines : Constructional features ,Driving mechanisms of Shaper, Operations done on Shaper,
Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations done on drilling machine,
Grinding: Grinding operation, classification of grinding processes (cylindrical, surface & centerless)

Module -3

Tool wear, Tool life and Machinability
Process of cutting tool failure, tool wears, types of tool wear, and tool wear index, the effect of tool wear on the machined surface, surface finish, machinability, machinability index/rating, tool life & variables affecting tool life, simple numericals on tool life, tool materials.
Cutting Fluids: Characteristics of Cutting fluids, Selections, and applying methods of cutting fluids.

Module -4

Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration.
Line & End Standards: Line and end standard, slip gauges, wringing phenomena, simple numerical on slip gauges.
Introduction to angular measurements : use of sine bars, sine center.

Module -5

Systems of Limits, Fits & Tolerance: Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, definition of fits, types of fits and their designation. shaft basis system , hole basis system simple problems..
G**auges:** Classification of gauges, Taylor's principle, design of GO, NO GO gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge.

Suggested Learning Resources:
Text Books:

1. Manufacturing Technology Vol I & II, P.N.Rao, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 1998.
2. A textbook of ProductionTechnology Vol I and II, Sharma, P.C., S. Chand & Company Ltd.
3. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
4. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education
5. Engineering Metrology, R.K. Jain, Khanna Publishers, 2009

Reference Books:

1. Workshop Technology Vol. I and II, Chapman W. A. J. Arnold Publisher New Delhi, 1998
2. Elements of Manufacturing Technology Vol II, Hajra Choudhary, S. K. and HajraChoudhary, A. K. Media

Publishers, Bombay
3. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.
4. Engineering Metrology R.K. Jain Khanna Publishers 2009

Web links and Video Lectures (e-Resources):

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: *http://nptel.ac.in/courses/112104028/.*
2.. https://youtu.be/i0nTCFArXZE?si=jfKx3a1drX94D7yU

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction & Metal Cutting Fundamentals	Introduction to Machining Science & Metrology, Basic Concepts of Mechanics & Geometry , Orthogonal vs. Oblique Cutting, Classification of Cutting Tools (single-point, multi-point) , Tool Signature for Single-Point Cutting Tools Mechanics of Orthogonal Cutting ,Chip Formation & Shear Angle , Introduction to Merchant Circle Diagram (basic understanding) Introduction to basic metal cutting machine tools, Parts of a Lathe & Various Operations.
2	Week 3-4: Machine Tool Technology	Differences between Turret & Capstan Lathes, Introduction to Milling Machines, Up Milling vs. Down Milling Concepts, Various Milling Operations Introduction to Shaping Machines - Construction & Operations , Introduction to Drilling Machines - Types (radial, bench) & Operations , Introduction to Grinding Processes - Types (cylindrical, surface, centerless).
3	Week 5-6: Tool Wear & Machinability	Process of Cutting Tool Failure & Types of Tool Wear , Tool Wear Index & Impact on Surface Finish , Machinability (concept and factors affecting it), Simple Numerical Problems on Tool Life & Tool Materials, Introduction to Cutting Fluids - Characteristics & Selection Criteria.
4	Week 7-8: Metrology & Measurements	Introduction to Metrology - Definition, Objectives & Classification, Standards of Length Measurement (wavelength standard, subdivisions) with demonstration Introduction to Line & End Standards (slip gauges), Wringing Phenomenon & Simple Numerical Problems on Slip Gauges, Introduction to Angular Measurements using Sine Bars & Sine Centers.
5	Week 9-10: Limits, Fits, & Tolerances	Definition of Tolerance & Importance in Assemblies, Principles of Interchangeability & Selective Assembly, Limits of Size & Types of Fits, Understanding Shaft Basis & Hole Basis Systems, Classification of Gauges based on Function.
6	Week 11-12: Gauges, & Review	Classification of Gauges based on Function, Design & Use of GO/NO GO Gauges (hands-on practice if possible), Different Types of Gauges simple numerical on slip gauges.

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 machine tools and measurements system
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
4	Demonstrations	Instructors can demonstrate proper operation of machines, tool handling techniques, and measurement procedures. This provides a visual reference for students before their hands-on practice
5	Project-Based Learning:	Assign projects where students design and manufacture a simple part using learned machining techniques. This encourages independent learning, application of skills, and teamwork.
6	Industrial Visit	Organize visits to manufacturing industries to expose students to real-world machining environments and advanced technologies
7	Flipped Class Technique	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
8	Hands-on Labs	Provide extensive laboratory sessions for students to practice operating lathe, milling machines, drilling machines, grinders, and measuring instruments. This practical experience solidifies theoretical knowledge and develops technical skills

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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 the fundamentals of Metal Cutting	Define fundamental terms related to metal cutting (orthogonal cutting, oblique cutting, chip formation, shear angle, etc.). Explain the mechanics of orthogonal cutting, including the significance of shear angle and the use of the Merchant circle diagram. Analyze the factors affecting cutting forces and power consumption.
2	Machine Tool Technology	Identify the various parts and functionalities of basic metal cutting machines (lathe, milling machine, drilling machine, grinding machine, etc.). Differentiate between up milling and down milling in milling operations. Understand the working principles of shaping machines and their functionalities. Explain the constructional features and operations performed on drilling machines (radial and bench types). Describe the principles of grinding operations and their classification (cylindrical, surface, centerless).
3	Machining Processes and Applications	Select appropriate machining processes (turning, milling, drilling, grinding, etc.) based on workpiece geometry and material properties. Understand the capabilities and limitations of different machining processes. Analyze the factors affecting surface finish and dimensional accuracy in machining
4	Tooling and Machinability	Interpret tool signature for single-point cutting tools. Analyze the process of cutting tool failure and identify different types of tool wear. Understand the concept of tool wear index and its impact on surface finish and tool life. Select appropriate tool materials based on machining requirements. Explain the concept of machinability and factors affecting it
5	Metrology and Measurement	Describe the objectives and classification of metrology. Explain the principles of length and angular measurement. Understand the use of line and end standards Solve numerical problems related to length calibration using slip gauges. Explain the use of sine bars and sine centers for angular measurements
6	Limits, Fits, Tolerances, Gauging and Inspection	Define tolerance and its importance in assembly Understand the concept of limits of size and different types of fits Select appropriate fits based on tolerance specifications. Classify different types of gauges (GO, NO GO, plain plug, ring, snap, etc.) based on Taylor's principle.

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

Course Outcomes (COs)

COs	Description
M23BME403.1	**Utilize** the acquired knowledge of metal cutting to Distinguish cutting processes, tools, chip formation and Merchant circle diagram
M23BME403.2	**Interpret** the construction and working of machine tools and their operations to produce machine parts
M23BME403.3	**Illustrate** the concept of Temperature in Metal Cutting, forms of wear in metal cutting, tool life and Cutting fluids
M23BME403.4	**Apply** the acquired knowledge of metrology and measurement, to interpret the standards, calibration of end bars, linear and angular measurement.
M23BME403.5	**Analyze** the different types of Fits, Limits, Tolerance and their applications in engineering design and gauging techniques to ensure parts meet dimensions.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME403.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME403.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME403.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME403.4	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME403.5	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME403	**3**	**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 course on Metal Cutting and Machining Processes help the students to develop a strong foundation in metal cutting principles, practical machining skills, and critical thinking abilities. This will prepare them to become future innovators who can contribute to the development and implementation of advanced manufacturing technologies, automation, and sustainable practices within the metal cutting industry will develop a valuable foundation for contributing to the future of manufacturing in several ways:

Advanced Manufacturing Techniques:

Understanding of Fundamentals: The knowledge gained about traditional machining processes will be a stepping stone for learning and adapting to advanced techniques like additive manufacturing (3D printing), hybrid machining (combining traditional with non-traditional methods).

Troubleshooting & Problem-Solving: Skills developed in tool selection, process optimization, and understanding tool wear will be crucial for troubleshooting issues and optimizing advanced machining processes.

Automation and Robotics:

Foundation for CNC and Robotics: The understanding of machining principles and machine operation will prepare students for working with CNC (Computer Numerical Control) machines and collaborative robots in the future.

Advanced Materials and Cutting Tools:

Adapting to New Materials: The knowledge of traditional machining principles will help students adapt to new materials with different properties that require specialized cutting tools and processes.

Sustainable Machining Practices:

Selection of Cutting Fluids: Learning about the characteristics and selection criteria of cutting fluids will contribute to the development of more sustainable and environmentally friendly cutting fluids in the future.

4th Semester	Professional Core Course (PCC) FLUID MECHANICS	M23BME404

1. Prerequisites

S/L	Proficiency	Prerequisites
1.	Physics (Mechanics)	Understanding concepts like force, pressure, work, and energy. These principles form the foundation for analyzing fluid forces, pressure distributions, and energy transfer within fluids
2.	Calculus (Differential and Integral)	Proficiency in differentiation (finding rates of change) and integration (finding total quantities) to understand concepts like fluid motion, pressure variations, and flow rates
3.	Units and its conversions	Familiarity with converting between different units of measurement (e.g., meters to centimeters, kilograms to grams) as fluid properties and calculations involve various units
4.	Problem-solving skills	Fluid mechanics involves applying concepts and equations to solve real-world problems. Strong problem-solving skills will be essential for analyzing scenarios and manipulating equations to find solutions
5.	Basic Programming (Optional)	Having some basic programming experience in languages like Python can be advantageous. Computational Fluid Dynamics (CFD) software that utilizes programming concepts

2. Competencies

S/L	Competency	KSA Description
1	Fluid properties, Pressure Variation and Pascal's Law	**Knowledge:** Understand the key properties of fluids: density, viscosity etc. Grasp the concept of pressure and its variation within a fluid at rest **Skills:** Apply knowledge of fluid properties to analyze their behavior Calculate pressure variations within a fluid at rest **Attitudes:** Develop a critical thinking approach to understand how fluid properties influence their behavior Demonstrate a curiosity to explore real-world applications of fluid properties and Pascal's Law in engineering
2	Fluid Statics & Buoyancy	**Knowledge:** Grasp the principles behind pressure measurement using manometers Understanding of Total pressure, center of pressure, buoyant force, center of buoyancy, metacenter, and metacentric height **Skills:** Apply relevant formulas and problem-solving techniques to analyze pressure differences, total force acting on submerged surfaces, and buoyancy **Attitudes:** Curiosity and willingness to learn and apply the basic concepts to solve problems based on fluid statics and buoyancy
3	Fluid Kinematics and Fluid Dynamics	**Knowledge:** Understand the different types of fluid flow. Grasp the concepts of fluid kinematics Know the principles of fluid dynamics, including Euler's equation and its derivation of Bernoulli's equation **Skills:** Apply the continuity equation to relate fluid velocity and density Solve problems using Bernoulli's principle used in venturimeter etc. **Attitudes:** Develop a problem-solving approach to analyze fluid motion and apply relevant equations effectively
4	Loss of head due to friction and Flow over bodies	**Knowledge:** Understand head loss (energy loss) and its effect on pipe flow Grasp boundary layer concept and its influence on flow over bodies **Skills:** Apply formulas to calculate head loss due to friction Estimate lift and drag forces based on body shape and flow **Attitudes:** Think critically about how body shapes and flow affect lift and drag Curiosity about fluid structure interactions

5	Compressible flows and CFD	**Knowledge:** Mach number, shock waves, and how fluids behave at high speeds Knowledge of fluid mechanics, boundary conditions, fluid flow equations **Skills:** Solve compressible flow problems **Attitudes:** Fascinated by how fluids move at high speeds and the power of CFD

3. Syllabus

FLUID MECHANICS **SEMESTER – IV**			
Course Code	M23BME404	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**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Course Objectives: This course will enable students to:

- To have a working knowledge of the properties of fluids & understand the continuum approximation.
- To calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
- To understand the flow characteristic and dynamics of flow field for various Engineering applications.
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modelling.
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

Module -1	
Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc. pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Numericals on properties of fluids and Pascal's law	L1, L2, L3
Module -2	
Fluid Statics and Buoyancy: **Fluid Statics:** Pressure measurement by simple, differential manometers. Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Numerical problems on manometers and total pressure and center of pressure **Buoyancy:** Buoyancy, center of buoyancy, meta center and meta centric height (analytic method only), stability of floating bodies. Numerical problems on metacentric height and buoyancy	L1, L2, L3
Module -3	
Fluid Kinematics and Fluid Dynamics **Fluid Kinematics:** Types of fluid flow, velocity and acceleration, continuity equation in cartesian co-ordinates, velocity potential function, stream function, Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems. **Fluid Dynamics:** Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter and related numericals.	L1, L2, L3
Module -4	
Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel. **Flow over bodies:** Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation & its control	L1, L2, L3
Module -5	
Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, applications	L1, L2, L3

Text Books:

- Fox, R. W., Pitchard,P., and McDonald, A. T., (2010), *Introduction to Fluid Mechanics*, 7th Edition, John Wiley & Sons Inc.
- Cimbala, J.M., Cengel, Y. A. (2010), *Fluid Mechanics: Fundamentals and Applications*, McGraw-Hill

- Frank M White., (2016), *Fluid Mechanics*, 8thEdition , McGraw-Hill

Additional References:

- *A text book of Fluid Mechanics and Hydraulic Machines*, Dr. R K Bansal, Laxmi publishers
- *Fundamentals of Fluid Mechanics*, Munson, Young, Okiishi & Hebsch, John Wiley Publicationss, 7th Edition

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Basics, Pressure variation and Pascal's law	**Week 1:** Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc. **Week 2:** Pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Numericals on properties of fluids and Pascal's law
2	Week 3-4: Manometers and Fluid Statics	**Week 3:** Fluid Statics: Pressure measurement by simple, differential manometers. **Week 4:** Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Numerical problems on manometers and total pressure and centre of pressure
3	Week 5-6: Buoyancy and Fluid Kinematics	**Week 5:** Buoyancy: Buoyancy, center of buoyancy, meta center and meta centric height, stability of floating bodies. Numerical problems on metacentric height and buoyancy **Week 6:** Fluid Kinematics: Types of fluid flow, velocity and acceleration, continuity equation, velocity potential function, stream function, Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems
4	Week 7-8: Fluid Dynamics and Loss of head due to friction	**Week 7:** Fluid Dynamics: Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, related numericals. **Week 8:** Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel.
5	Week 9-10: Flow over bodies	**Week 9:** Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control **Week 10:** Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles.
6	Week 11-12: Introduction to CFD	**Introduction to CFD:** Necessity, limitations, philosophy behind CFD, applications

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Chalk and Talk	This method is very useful in solving problems based on fluid flow thereby strengthening the competencies
2	Lecture Method	Utilize various teaching methods within the lecture format to reinforce competencies
3	Video/Simulation	Incorporate visual aids like videos/simulations/animations to enhance understanding of types of fluid flow concepts
4	Laboratory Demonstrations	Taking students to Fluid Mechanics and Machinery laboratory to reinforce practical skills associated with competencies
5	Collaborative Learning	Encourage collaborative learning for improved competency application
6	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of 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

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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	Identify and calculate fluid properties	Students will gain knowledge of the basic properties of fluids such as Density, Specific gravity, Viscosity, capillarity etc.
2	Utilize manometers for pressure measurement	Understand the principles of manometers and use them to measure pressure in fluids
3	Classify fluid flow types	Categorize fluid flow based on its characteristics (steady / unsteady) and behavior (laminar / turbulent)
4	Analyze head loss due to friction in pipes	Understand the concept of head loss due to friction in pipes and analyze the factors contributing to major losses.
5	Explain Mach number and its relation to compressibility	Understand the concept of Mach number and its significance in identifying compressibility effects in fluid flow.

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

Course Outcomes (COs)

COs	Description
M23BME404.1	Apply the concept of fluid properties used in understanding fluid behavior
M23BME404.2	Interpret the principles of pressure, pressure measurement, fluid statics, buoyancy and floatation
M23BME404.3	Assess practical problems in fluid dynamics and kinematics using fundamental concepts.
M23BME404.4	Analyze the problems on major and minor energy losses that are involved in fluid flow and flow past immersed bodies
M23BME404.5	Evaluate compressible flows and Computational Fluid Dynamics (CFD) using basic concepts of fluid mechanics

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME404.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME404.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME404.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME404.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME404.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME404	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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 "Fluid Mechanics" 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:

- **Advanced Flow Control:** New methods for controlling boundary layer separation and turbulence will lead to significant advancements in areas like drag reduction (e.g., for ships and airplanes), improving heat transfer efficiency, and noise reduction.
- **Microfluidics and Nanofluids:** The miniaturization of fluid systems will have a profound impact on medical diagnostics, drug delivery, and lab-on-a-chip devices. Fluid mechanics will be essential for designing and optimizing these microfluidic systems.
- **Biomimetic Design:** Nature offers a wealth of inspiration for fluid mechanics. Studying how organisms like fish or birds achieve efficient locomotion will lead to the development of more efficient and sustainable designs for vehicles and machines.
- **Renewable Energy:** Fluid mechanics will be crucial in optimizing wind turbines, hydroelectric power plants, and other renewable energy technologies for maximum efficiency and performance.
- **Computational Fluid Dynamics (CFD) Advancements:** Improvements in CFD software and hardware will allow for more complex and realistic simulations of fluid flow, leading to better design and optimization across various engineering disciplines.
- **Space Exploration:** Fluid mechanics plays a vital role in spacecraft design, propulsion systems, and understanding fluid behavior in microgravity environments. Future space exploration missions will rely heavily on advancements in fluid mechanics.
- **Climate Change Mitigation:** Understanding fluid dynamics is essential for accurate climate modeling and developing effective strategies for mitigating climate change. For example, fluid mechanics can help predict weather patterns and improve disaster preparedness.
- **Ocean Engineering:** From offshore wind farms to underwater vehicles, fluid mechanics is crucial for the design and operation of various ocean engineering projects. Future advancements will enable exploration and resource utilization in the deep ocean.
- **Personalized Medicine:** Fluid mechanics principles can be applied to model blood flow in the human body, aiding in the diagnosis and treatment of cardiovascular diseases. This could lead to personalized medicine approaches based on individual fluid dynamics profiles.

4th Semester	Professional Core Course (PCC) KINEMATICS OF MACHINES	M23BME405

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Physics	Mechanics: Basic principles of motion, forces, and energy. Newton's Laws of Motion: Fundamental laws governing the movement of objects.
2	Technical Drawing	Engineering Drawing: Ability to read and interpret technical drawings and schematics.
3	Mathematics	Algebra: Understanding equations and solving for variables. Trigonometry: Understanding angles, sine, cosine, and tangent functions. Calculus: Basics of differentiation and integration.
4	Engineering Mechanics	Statics: Study of forces in equilibrium. Dynamics: Study of forces and torques and their effect on motion.
5	Computer Skills	CAD Software: Basic knowledge of computer-aided design (CAD) software for modeling and simulating mechanisms.
6	Programming Fundamentals	Programming: Basic understanding of programming for simulating kinematic systems (optional but helpful).
7	Previous Coursework	Introductory Physics Engineering Mechanics (Statics and Dynamics) Basic Mathematics (Calculus and Linear Algebra) Technical Drawing and CAD

2. Competencies

S/L	Competency	KSA Description
1	**Mechanisms identification**	**Knowledge:** Understanding the various terminologies related to Mechanisms, different types of Mechanism. **Skills:** Identifying the different types of mechanism in simple Machines. **Attitudes:** Appreciation for the importance of mechanisms in Mechanical system design.
2	**Velocity and Acceleration Analysis of Mechanisms by graphical method**	**Knowledge:** Understanding the concept of displacement, velocity and acceleration applied to various linkages of the mechanism. **Skills:** Able to find the velocity and acceleration of various components of simple mechanisms by drawing velocity and acceleration polygons. **Attitudes:** Appreciation for importance of finding velocity and acceleration of various linkages in the mechanism.
3	**Velocity and Acceleration Analysis of Mechanisms by analytical method**	**Knowledge:** Understanding the concept of displacement, velocity and acceleration applied to various linkages of the mechanism. **Skills:** Able to find the velocity and acceleration of various components of simple mechanisms by using mathematical models **Attitudes:** Appreciation for importance of finding velocity and acceleration of various linkages in the mechanism.
4	**Kinematic analysis of gears and gear trains**	**Knowledge:** Understanding the **Gear terminology, law of gearing,** types of gear and gear trains and working of gears and gear trains **Skills:** Able to find the various kinematic parameters pertaining to gear and gear train for

		the given set of data **Attitudes:** Appreciation for the role of gear and gear trains in Mechanical system design.
5	**Analysis of cams**	**Knowledge:** Understanding of types of Cams, types of followers and different types of follower motions **Skills:** Ability to write the cam profile for the given type of follower motions **Attitudes:** Appreciation for the role of cams in Mechanical system design..

3. Syllabus

KINEMATICS OF MACHINES SEMESTER – IV			
Course Code	M23BME405	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**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Course objectives: This course will enable students to: 1. Familiarize with mechanisms and motion analysis of mechanisms. 2. Understand methods of mechanism motion analysis and their characteristics. 3.Analyse motion of planar mechanisms, gears, gear trains and cams			
Module -1			
Introduction: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. **Kinematic Chains and Inversions:** Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.			L1, L2, L3
Module -2			
Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. **Velocity Analysis by Instantaneous Center Method:** Definition, Kennedy's theorem, Determination of linear and angular velocity of various links of four bar mechanism, slider crank mechanism using instantaneous center method			L1, L2, L3
Module -3			
Spur Gears: Gear terminology, law of gearing, Path of contact. Arc of contact, Contact ratio of spur gear, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth.			L1, L2, L3
Module -4			
Gear Trains: Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.			L1, L2, L3
Module -5			
Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion			L1, L2, L3
Text Books: **1. Rattan S.S, Theory of Machines,** Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4thEdition, 2014. **2. "Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006 **REFERENCEBOOKS:** 1. "Theory of Machines & Mechanisms ", J.J. Uicker, G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009. 2.Mechanism and Machine theory, Ambekar, PHI, 2007			

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction and Kinematic Chains and Inversions	**Introduction:** Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. **Kinematic Chains and Inversions:** Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.
2	Week 3-4: Velocity Analysis by Instantaneous Center Method	Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method
3	Week 5-6: Velocity Analysis by Instantaneous Center Method	Definition, Kennedy's theorem, Determination of linear and angular velocity of various links of four bar mechanism, slider crank mechanism using instantaneous center method
4	Week 7-8: Spur Gears	Gear terminology, law of gearing, Path of contact. Arc of contact, Contact ratio of spur gear, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth.
5	Week 8-10: Gear Trains	Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.
6	Week 10-12: Cams	Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.

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	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Multiple Representations	Introduce topics in various representations to reinforce 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)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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 fundamental principles of Kinematics as they apply to machines.	• Students will understand the terminology and classification of mechanisms and machines. • Comprehend the fundamental principles of kinematics as they apply to machines.
2	Analyzing Mechanisms	• Students will learn to Analyze different types of mechanisms and their components, including links, joints, and kinematic pairs. • Study the mobility and degrees of freedom of mechanisms.
3	Kinematic Analysis	• Students will able to perform kinematic analysis of various mechanisms to determine position, velocity, and acceleration of different components. • Use graphical and analytical methods for kinematic analysis.
4	Application of Kinematic Principles	• Students will able to apply kinematic principles to real-world engineering problems

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

Course Outcomes (COs)

COs	Description
M23BME405.1	**Apply** kinematic concepts to analyze and identify mechanisms and their inversions, including four-bar, single slider crank, and double slider crank chains
M23BME405.2	**calculate** the various parameters of spur gears and by understanding the fundamentals of spur gears
M23BME405.3	**Construct** the cam profile for the given motion specifications
M23BME405.4	**Motion analysis** of different types of gear trains
M23BME405.5	**Analyze** a mechanism for displacement, velocity and acceleration at any point in the moving link by understanding the concept of machines and mechanisms

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME405.1	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME405.2	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME405.3	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**	-
M23BME405.4	-	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME405.5	-	**3**	-	-	-	-	-	-	-	-	-	-	-	**3**
M23BME405	**3**	**3**	-	-	-	-	-	-	-	-	-	-	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

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

10. Future with this Subject

The "Kinematics of Machines" 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 Mechanical system design. Here are some notable contributions:

Robotics and Automation: The principles of kinematics are fundamental to the design and control of robots and automated systems. Advances in these fields will drive the development of more sophisticated kinematic models.

Additive Manufacturing: would help in learning about Additive Manufacturing by providing a foundational understanding of how machines and mechanisms move and function. This knowledge is crucial in Additive Manufacturing for designing and implementing the necessary motion systems, such as those controlling the movement of 3D printers.

4th Semester	Professional Core Laboratory (PCL) MECHANICAL MEASUREMENTS AND METROLOGY LAB	M23BME406

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Engineering Mathematics**	Knowledge of basic trigonometry (sine, cosine, tangent): This is needed in calculations associated with angular measurements and geometric features of objects.
2	**Engineering Physics**	Familiarity with the working principles and applications of common measuring instruments encountered in physics. Examples include: Linear Measurement: Vernier calipers, micrometers, dial gauges and Angular Measurement: Bevel protractor, sine bar
3	**Error analysis**	Knowledge of accuracy, precision, and different types of errors (systematic and random). This is crucial for interpreting experimental data and understanding limitations of measuring instruments.
4	**Calibration**	Understanding the concept of calibration and its importance in maintaining accuracy of measuring instruments.
5	**Familiarity with using measuring instruments**	Understanding of the concept of least count and its application in various measuring instruments, such as: Vernier caliper, Micrometer, Dial gauge, ability to interpret readings from different measuring instruments and calculate total reading based on least-count.
6	**Data Acquisition and Analysis:**	Basic skills in recording and analyzing experimental data, including calculations of errors and uncertainties.
7	**Laboratory Safety Procedures**	Knowledge on safe practices while using lab equipment, including handling measuring instruments and hazardous materials

2. Competencies

S/L	Competency	KSA Description
1	**Fundamental knowledge**	**Knowledge** • Concepts of measurement including units, errors, and uncertainty. • Working principles of various mechanical measuring instruments such as calipers, micrometers, and gauges. **Skill** • Ability to use measuring instruments to take accurate and precise measurements of linear dimensions, angles, and other mechanical properties. • Ability to analyze and interpret measurement data to identify trends and sources of error. • Ability to perform basic calibration procedures on common measuring instruments **Attitude** • Attention to precision and accuracy in performing measurements and recording data. • Critical thinking and problem-solving skills to troubleshoot measurement issues and identify sources of error. • Commitment to safety and quality in the laboratory environment
2	**Concept of Metrology**	**Knowledge** • Knowledge on units, standards, calibration, and how to quantify and express measurement uncertainties. • Different types of Errors in measurement **Skill** • Ability to perform basic mechanical measurements like length, diameter, angle, surface roughness, force, and other mechanical parameters. • Able to analyze the data and interpret the results in the context of the

		experiment. **Attitude** • Compute detail and accuracy in measurements. • Develop a strong work ethic and a commitment to making accurate measurements. • Importance of following proper procedures and taking care of measuring instruments.
3	**Calibration techniques**	**Knowledge** • Know the concept of calibration, its importance in ensuring measurement. • Knowledge on different calibration methods for various instruments. **Skill** • Able to Identify and apply appropriate measuring instruments for various mechanical dimensions like length, angle, surface roughness etc. • Perform calibration procedures on instruments like micrometers, pressure gauges etc. according to established standards. • Analyze and interpret measurement data to assess accuracy, identify sources of error, **Attitude** • Recognize the limitations of instruments and potential sources of error during calibration and measurement. • Appreciate the importance of maintaining measurement traceability through proper calibration practices and documentation.
4	**Geometric measurements**	**Knowledge** • Concepts of roundness and circularity, including how these measurements are performed and interpreted. • Knowledge on Understanding of screw thread parameters (major diameter, minor diameter, pitch, etc.) and gear tooth profiles (pressure angle, addendum, dedendum, etc.). • Knowledge on measuring instruments such as Vernier calipers, micrometers, and comparators. **Skill** • Ability to measure screw thread parameters using 2-wire or 3-wire methods according to industry standards. • Skill in analyzing gear tooth profiles using gear tooth Vernier calipers or gear tooth micrometers, including calculating relevant dimensions. • Capability to assess the roundness and circularity of objects using mechanical comparators, interpreting the data to ensure components meet specifications. **Attitude** • Attention to detail when performing measurements, recognizing the importance of accuracy and precision. • Careful handling of measuring instruments to ensure they are calibrated and used correctly to maintain accuracy.
5	**Analysis of force in cutting tool**	**Knowledge:** • Knowledge of the different types of cutting tool dynamometers (lathe, drill) and their operating principles. • Concepts of various forces acting on a cutting tool during machining operations. **Skill:** • Ability to set up, calibrate, and operate cutting tool dynamometers safely and effectively. • Acquire data on cutting forces during machining experiments and interpreting the data to understand the relationship between cutting forces and machining parameters. **Attitude:** • develop skills to troubleshoot any issues encountered during the experiments and analyze the results to draw meaningful conclusions.

3. Syllabus

MECHANICAL MEASUREMENTS AND METROLOGY LAB SEMESTER – III			
Course Code	**M23BMEL406**	**CIE Marks**	**50**
Number of Lecture Hours/Week (L: T: P: S)	**(0:0:2:0)**	**SEE Marks**	**50**
Total Number of Lecture Hours	**15 Sessions**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**
Examination nature (SEE)	**Practical**		

Course objectives: This course will enable students to:

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

Sl. No	Experiments	
MECHANICAL MEASUREMENTS:		
1	Calibration of Pressure gauge	L2 L3
2	Calibration of Thermocouple	L2 L3
3	Calibration of LVDT	L2 L3
4	Calibration of Load cell	L2 L3
5	Determination of modulus of elasticity of a mild steel specimen using strain gauges.	L2 L3
6	Calibration of Micrometre	L2 L3
METROLOGY		
7	Measurement of gear tooth profile using gear tooth Vernier	L2 L3
8	Measurement of angle using Sine bar	L2 L3
9	Measurement of angle using Sine Center	L2 L3
10	Measurement of gears & Screw thread using Profile Projector	L2 L3
11	Measurements of Screw thread Parameters using two wire or Three-wire methods.	L2 L3
	Demonstration Experiments (For CIE)	
12	Measurement of alignment using Autocollimator / Roller set	L2 L3
13	Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.	L2 L3
14	Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator	L2 L3

Text Books:

14. Mechanical Measurements Beckwith Marangoni and Lienhard Pearson Education 6th Ed., 2006
15. Engineering Metrology R.K. Jain Khanna Publishers 2009
16. Engineering Metrology and Measurements Bentley Pearson Education
17. Engineering Metrology Gupta I.C Dhanpat Rai Publications

Reference Books:

1. Engineering Metrology and Measurements N.V.Raghavendra and L. Krishnamurthy Oxford University Press.
2. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	• Introduction to mechanical measurements and Metrology Lab, • Calibration of Pressure Gauge, • Calibration of Thermocouple, and • Calibration of LVDT
2	Week 3-4	• Calibration of Load cell • Determination of modulus of elasticity of a mild steel specimen using strain gauges. Calibration of Micrometer
3	Week 5-6	• Measurement of gear tooth profile using gear tooth Vernier, • Measurement of angle using Sine bar
4	Week 7-8	• Measurement of angle using Sine Center, • Measurement of gears & Screw thread using Profile Projector and • Measurements of Screw thread Parameters using two wire or Three-wire methods.

5	Week 9-10	• **Demonstration of** Measurement of alignment using Autocollimator / Roller set and • Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
6	Week 11-12	• **Demonstration of** Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer and • **Internal Assessment**

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Pre-Lab Sessions**	Lecturer delivers discussions on the theoretical concepts relevant to the specific lab experiment. This could cover topics like: **1.** The principles of measurement, Uncertainty and errors in measurement, Operation and functionalities of the measuring instruments used in the experiment and Calibration methods for instruments.
2	**Pre-Lab Readings**	Students are assigned relevant readings from textbooks or lab manuals, to make their understanding before entering the lab.
3	**Experimentation**	Students work in groups or individually to perform the assigned experiments as outlined in the lab manual. This involves: **2.** Setting up the measuring instruments according to the procedure. **3.** Taking measurements of the designated objects or parameters. **4.** Recording data meticulously. **5.** Performing calculations based on the collected data. **6.** Analyzing the results and interpreting their meaning.
4	**Demonstration & Guidance**	Lecturer providing guidance and assistance to students as needed. This could involve: **8.** Demonstrating proper use of the instruments. **9.** Addressing questions and troubleshooting any issues encountered. **10.** Ensuring students adhere to safety protocols.
5	**Lab Reports, conclusion & Inference**	Students prepare reports summarizing their lab experience. These reports typically include: **11.** Objectives of the experiment. **12.** Description of the procedure followed. **13.** Recorded data in tables or graphs. **14.** Calculations performed and analyzed results. **15.** Discussion of observations, sources of error, and conclusions drawn

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation

- 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 for 100 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 20marks (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 50 marks

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	**Fundamentals of Measurement**	Students will learn about different types of errors (systematic, random, gross), methods to minimize errors, and the importance of calibration in maintaining measurement accuracy
2	**Calibration Techniques**	Students will perform calibration of instruments like pressure gauges, , Load Cell, LVDT, Micrometer and thermocouples, and learn the importance of traceable calibration standards.
3	**Linear and Angular measuring instruments**	Students will explore instruments like Vernier calipers, micrometers, slip gauges, and their working principles and sine bars, autocollimators, and understand their applications in measuring angles & linearity and checking alignment of mechanical components.
4	**Measurement of Surface Properties**	section covers the concept of surface roughness, its impact on performance, and instruments like Perthometer used for surface surfnace analysis.
5	**Gear and thread Measurements**	specialized instruments like gear tooth Vernier's, micrometers, and techniques for measuring thread dimensions using two-wire or three-wire methods.

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

Course Outcomes (COs)

COs	Description
M23BMEL406.1	Apply for its correctness and comprehend the calibration procedure/ measurement principles for evaluating measuring instruments/ gauges.
M23BMEL406.2	Asses the various parameters associated with components to be inspected using various measuring instruments and gauges.
M23BMEL406.3	Analyze and interpret the results to draw valid conclusions through standard test procedures using various measuring instruments/ gauges.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BMEL406.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BMEL406.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BMEL406.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BMEL406	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	Total
Total	**17**	**17**	**16**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	Total
Total	**24**	**14**	**12**	**20**

10. Future with this Subject

- **Advanced Instrumentation:** Sophisticated instruments like 3D scanning systems, coordinate measuring machines (CMMs), and laser-based measurement tools. These will enable highly

accurate and intricate measurements, crucial for the development of miniaturized components and complex mechanical systems.

- **Integration with Automation and Robotics:** The lab will likely embrace automation and robotics for tasks like automated calibration procedures, data acquisition, and manipulation of delicate objects. This will enhance efficiency, improve data quality, and minimize human error.
- **Data Acquisition and Analysis**: Students will gain expertise in using sophisticated software for data collection, visualization, and interpretation. This will equip them to analyze complex measurement data and make informed engineering decisions.
- **Industry 4.0 Integration:** The lab will likely integrate concepts from Industry 4.0, such as the Internet of Things (IoT) and cloud-based data storage. This will allow for real-time monitoring of instruments and remote data access, facilitating collaboration and knowledge sharing.

4th Semester	Engineering Science Course (ESC) NON-TRADITIONAL MACHINING	M23BME407A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Sciences**	**Physics**: Understanding the principles of electricity, magnetism, optics, and wave propagation. **Chemistry**: Knowledge of chemical reactions, corrosion, and material properties
2	**Mechanical Engineering**	**Mechanics of Materials**: Knowledge of stress-strain relationships, material strength, and deformation. **Thermodynamics**: Understanding of heat transfer, energy transformations, and thermal effects on materials.
3	**Electrical engineering**	**Circuit Theory**: Basics of electrical circuits, including voltage, current, resistance, and power. **Electromagnetism**: Principles of electromagnetic fields and their applications.
4	**Material Science**	**Material Properties**: Familiarity with the physical, chemical, and mechanical properties of different materials. **Material Characterization**: Techniques for analyzing material composition and structure.
5	**Analytical and Computational Skills**	Understanding of process optimization techniques.
6	**Process-Specific Knowledge**	Role of dielectric fluid and electrode materials. Fundamentals of laser-ma Types of lasers and their applications in machining trial interaction

2. Competencies

S/L	Competency	KSA Description
1	**Non-Traditional Machining**	**Knowledge:** Understands the limitations of traditional machining for complex materials, geometries, and tool wear. Understands the factors influencing process selection for non-traditional machining **Skills:** Ability to analyze machining requirements and select the most suitable non-traditional process. Ability to interpret process results like surface finish, dimensional accuracy and make adjustments. **Attitudes:** Continuous learning mindset on advancements in non-traditional machining technologies. Exploring new applications and possibilities for non-traditional machining processes.
2	**Mechanisms**	**Knowledge:** Knowledge of the scientific principles behind each NTM process, like electromagnetism for EDM. Knowledge of material properties and their interaction with different NTM mechanisms **Skills:** Ability to select the appropriate NTM process based on material properties, design complexity, and desired surface finish Skill in designing, planning, and simulating NTM processes using specialized software . **Attitudes:** problem-solving mindset developed to tackle challenges related to material selection, NTM process selection, and optimizing machining parameters Eagerness to learn about new advancements and research areas in NTM
3	**Process characteristics**	**Knowledge:** Understanding the fundamental mechanisms by which each NTM process

		removes material, such as thermal energy for EDM for selecting the appropriate process and predicting its effects on the workpiece. Understanding the applications and process suitability for informed decision-making when selecting the most appropriate NTM process for a given task. **Skills:** Considering the material properties, design requirements, and desired outcomes, helps to select the most appropriate NTM process for the job. The ability to identify common problems, such as poor surface finish or dimensional inaccuracy, and implement corrective actions to resolve them is a valuable skill. **Attitudes:** Selecting the optimal NTM process often involves evaluating the trade-offs between different options.
4	**Process parameters**	**Knowledge:** Understanding the effects of process parameters on machining outcomes Understanding of each NTM process and its core principles **Skills:** Ability to select appropriate process parameters based on material properties, design requirements, and desired outcomes Ability in setting up and operating NTM equipment to achieve desired parameter values **Attitudes:** Problem-solving skills to address challenges related to parameter optimization Analytical thinking for evaluating the impact of parameter changes

3. Syllabus

NON-TRADITIONAL MACHINING- M23BME407 SEMESTER –IV			
Course Code	**M23BME407**	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:
- To learn various concepts related to modern machining processes & their applications.
- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes. .

Module -1

Introduction to Non-traditional machining

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Module -2

Ultrasonic Machining (USM):

Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM):

Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Module -3

Electrochemical machining (ECM):

Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation,. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes,. Applications ECM Electrochemical grinding and electrochemical honing process. Advantages,

disadvantages and application of ECG, ECH. **Chemical Machining (CHM):** Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.
Module -4
Electrical Discharge Machining (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Traveling wire EDM. **Plasma Arc Machining (PAM):** Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.
Module -5
Laser Beam Machining (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. **Electron Beam Machining (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.
TEXT BOOKS: 1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000 2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984. **REFERENCE BOOKS:** 1. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001 2. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000 3. Modern Machining process, Aditya, 2002. 4. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2	**Introduction to Non-traditional machining** Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.
2	Week 3-4	**Ultrasonic Machining (USM):** Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.
3	Week 5-6	**Abrasive Jet Machining (AJM):** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.
4	Week 7-8	**Electrochemical machining (ECM):** Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation,. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate,Applications ECM Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.
5	Week 9-10	**Chemical Machining (CHM):** Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.
6	Week 11-12	**Plasma Arc Machining (PAM):** Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma

		torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.
7	Week 13-14	**Laser Beam Machining (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. **Electron Beam Machining (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

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	Videos	Incorporate visual aids like videos to enhance understanding of materials engineering concepts.
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.
5	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)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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	Fundamentals of Non-Traditional Machining	Understand the key differences between NTM and traditional machining processes, including the types of energy used and the materials they are suited for.
2	Specific NTM Processes	Material removal through controlled electrical spark discharges, Material removal through an electrochemical dissolution process.
3	Applications of NTM	Analyze the suitability of NTM for different materials and applications. Identify key application areas of NTM across different industries
4	Selection and Optimization of NTM Processes	Understanding of the key process parameters for each NTM process and their impact on machining outcomes.

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

Course Outcomes (COs)

COs	Description
M23BME407.1	**Understand the** fundamentals of non-traditional machining process and its need, compare with Traditional machining process.
M23BME407.2	**Interpret** the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM & AJM.
M23BME407.3	**Identify** the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations
M23BME407.4	**Illustrate** the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM
M23BME407.5	**Analyze the** need of LBM AND EBM along with constructional features process characteristics, applications, advantages, and limitations.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME407.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME407.2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
M23BME407.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME407.4	3	-	-	-	-	-		-	-	-	-	-	2	-
M23BME407.5	3	3	-	-	-	-	-	-	-	-	-	-	2	-
M23BME407	3	3	-	-	-	-	-	-	-	-	-	-	2.4	-

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 "Non-Traditional Machinig" course in the fourth semester of the B.E Mechanical program lays a strong foundation for several future courses in the undergraduate program. The future of non-traditional machining (NTM) is bright, driven by the growing need for advanced materials and complex designs in various industries

Addressing limitations of traditional machining: Traditional machining methods often struggle with hard, brittle, or heat-sensitive materials. NTM processes like EDM and USM excel in machining these very materials, and future advancements will likely see them become even more precise and efficient.

Complex geometries: With the increasing demand for intricate designs in aerospace, medical devices, and other sectors, NTM processes like AWJM and LBM will play a key role. Expect further developments in these areas to create even more intricate shapes and features with tighter tolerances.

Integration with automation and Industry 4.0: As automation and smart manufacturing take hold, NTM processes will be seamlessly integrated into these systems. Research in areas like sensor integration and real-time process monitoring will be crucial for optimizing NTM for automated environments. This will lead to more efficient and consistent production.

Hybrid and novel NTM techniques: The future is likely to see a rise in hybrid NTM processes that combine different techniques, like combining laser with chemical etching, to achieve even greater capabilities. Additionally, research into entirely new NTM methods based on emerging technologies like nanotech machining is an exciting possibility.

Sustainability: Manufacturing is increasingly focused on minimizing environmental impact. NTM processes can contribute to this by reducing waste material and enabling the use of recycled materials. Research into cleaner and more efficient NTM techniques, like using environmentally friendly electrolytes in ECM, will be important for sustainable manufacturing.

In conclusion, studying non-traditional machining offers a gateway to a field that is critical for manufacturing innovation. With its focus on advanced materials, complex designs, automation, and sustainability, NTM is an excellent field to pursue for a career at the forefront of machining technology.

4th Semester	Engineering Science Course (ESC) DIE, MOLD AND TOOL ENGINEERING	M23BME407B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Basic Mathematics**	Proficiency in mathematics, including algebra, geometry, and trigonometry, is essential for understanding concepts such as measurements, calculations, and geometric relationships in manufacturing processes.
2	**Physics**	A basic understanding of physics concepts, such as mechanics, thermodynamics, and material properties, can provide a foundation for understanding the principles underlying various manufacturing processes.
3	**Materials Science**	Knowledge of materials science, including properties of metals, polymers, ceramics, and composites, helps in understanding material selection, processing techniques, and performance characteristics in manufacturing.
4	**Engineering Drawing**	Familiarity with engineering drawings, geometric dimensioning and tolerance (GD&T), and blueprint reading is important for interpreting design specifications and communicating with engineers and designers.
5	**Computer Skills**	Basic computer skills, including proficiency in using software tools such as spreadsheets, word processors, and computer-aided design (CAD) software, are often required for documentation, data analysis, and design tasks.
6	**Mechanical Engineering Fundamentals**	Understanding of basic mechanical engineering principles, such as statics, dynamics, mechanics of materials, and fluid mechanics, provides a solid foundation for studying manufacturing processes and equipment.
7	**Problem-Solving Skills**	Development of critical thinking and problem-solving skills helps in analyzing manufacturing problems, optimizing processes, and implementing improvements in efficiency and quality.
8	**Laboratory Experience**	Hands-on experience in laboratory settings, including conducting experiments, using equipment and tools, and performing material testing, can enhance understanding and application of manufacturing principles.
9	**Previous Coursework**	Completion of related coursework in subjects such as machining, materials processing, mechanical design, and industrial engineering can provide a strong foundation for studying manufacturing processes at a more advanced level.

2. Competencies

S/L	Competency	KSA Description
1	**Terminology and components understanding about Dies**	**Knowledge:** Understanding of basic terminology related to dies and molds. Knowledge about integrated reflexes of various components in dies and molds **Skills:** Ability to apply knowledge of dies and molds in its selection for various types of product processing. **Attitudes:** Appreciation for the importance of various dies and molds and their necessities in various types of product processing
2	**Types of dies and molds**	**Knowledge:** Understanding various types of dies and molds **Skills:** Analyzing the adaptability of various types of dies and molds for different product types **Attitudes:** Appreciation for the role of various dies and molds in manufacturing processes
3	**Defect analysis**	**Knowledge:** Understanding different types of defects in dies and molds **Skills:** Identify common defects seen in dies and molds and analyze its effects under operating conditions **Attitudes:** Appreciation the capacities of investigating the root cause of various defects

4	**Design of jigs & fixtures**	**Knowledge:** Understanding the functions of jigs and fixtures and differences between them **Skills:** Design jigs and fixtures to increase efficiency and meet specific production needs **Attitudes:** Valuing the importance 3-2-1 principle to accurately position work pieces in fixtures
5	**Design of cutting tools**	**Knowledge:** Understanding the basic concepts of tooling and general tool design procedure for single point and multi point cutting tool. **Skills:** Optimizing tool designs to achieve the best balance between performance, durability, and manufacturability. **Attitudes:** Openness to test and select different materials for cutting tools based on target applications
6	**Press tools**	**Knowledge:** Understanding of basic and operations of various types of power tools **Skills:** Ability to solve problems related to different dies for different components **Attitudes:** Appreciation for the versatility of press tools in maintaining high standards during manufacturing processes

3. Syllabus

DIE, MOLD & TOOL ENGINEERING SEMESTER – IV			
Course Code	**M23BME407B**	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 enables students to: • Understand the basic principles, concepts and types of die, mold, and tool engineering • Differentiate between single cavity, multi-cavity, combination, and unit dies. • Compare and contrast different types of molding processes • Master the principles of designing single-point and multi-point cutting tools, including considerations for strength, rigidity and tool geometry. • Develop skills in optimizing tool designs to enhance manufacturability, efficiency, and performance.			
Module -1			
Dies: Terminology: Core, cavity, sprue, slug, fixed & movable cores, finger cams, draft, and ejector pins ejector plates, gate, goose nozzle, over-flow, platten, plunger, runner, vent, water-line etc. **Types of Dies**: Single cavity, multi cavity dies, combination dies, unit dies, advantages and disadvantages of types of dies. Die casting alloys, defects in die casting, finishing trimming and inspection of die casting components, safety and modern trends in die casting dies**.**			L1, L2, L3
Module -2			
Molding: Definition, molding methods – bench, floor, pit machine types, molding machines – jolting, squeezing, san blower types, different techniques used in molding **Conventional molding processes** – Green sand type, dry sand type, core sand type molding processes **Special molding processes** – Shell molding, CO2 molding, investment molding, Injection and Blow molding processes **Molding process considerations** – filling the mold cavity, risers, chill blocks and padding			L1, L2, L3
Module -3			
Jigs and Fixtures: Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures. **Location**: 3-2-1 Principle of location, different types of locating elements. **Clamping**: Principles of clamping, types of clamping devices, and power clamping. Different **types of drill jigs** and Drill bushes. Different **types of fixture design**: Turning fixtures, milling fixtures, grinding fixtures, fixturing for CNC machining centers, and modular fixtures.			L1, L2, L3
Module -4			

Introduction to tool design: Tooling, requirements of a tool designer, general tool design procedure. **Design of Single point Cutting Tool**: Design of single point lathe tool, Design of shank dimension using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry. **Design of Multi Point Cutting Tool**: Drill bit design of elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry. **Design of milling cutter:** Design of elements like number of teeth and height circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry	L1, L2, L3
Module -5	
Press tools: Classification and working of power presses. Concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die, Centre of pressure, and strip layout. Simple, progressive, compound, combination and inverted dies. Design problems on blanking and piercing dies for simple components. **Bending dies** – Introduction, bend allowance, spring back, edge bending die design. **Drawing dies** – Single action, double action and triple action dies, factors affecting drawing and drawing die design.	L1, L2, L3

Text Books:

1. Manufacturing technology (foundry forming and welding) P.N. Rao, Tata McGraw Hill Pub, Edn.1996 Die Casting Die Design, Burton 2000
2. Manufacturing Science, Ghosh, A. and Mallik, A. K., (2017), East-West Press.
3. Tool Engineering & Design, G R Nagpal, Khanna Publishers Sixth Edition

Reference Books:

1. Production Technology, HMT, Tata McGraw Hill Publications, 2013
2. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
3. Tool Design, Cyril Donaldson, George H Lecain, V C Goold, McGraw Hill Publications, 5th edition 2017
4. Jigs & Fixtures, P H Joshi, McGraw Hill Education, 3rd edition 2010

Video/Online Tutorials:

1. Complete Mold design lectures by TechDesign Study - https://www.youtube.com/playlist?list=PL4bQDkm2eks3LAbHw56sIA1cIT8-DhAH1
2. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/
3. MOOCs: http://nptel.ac.in/courses/112105126/.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	**Week 1-2**	• Terminologies of Dies • Single cavity, multi cavity dies, combination dies, unit dies, Advantages and disadvantages of types of dies • Die casting alloys • Defects in die casting
2	**Week 3-4**	• Finishing trimming and inspection of die casting components, • Safety and modern trends in die casting dies. • Molding methods • Molding machines
3	**Week 5-6**	• Conventional molding processes • Special molding process • Molding process considerations • Functions and differences between jigs and fixtures • Advantages in mass production
4	**Week 7-8**	• Design principles, economics of jigs and fixtures • 3-2-1 Principle of location, different types of locating elements. • Principles of clamping, types of clamping devices, and power clamping. • Design of Drill jigs & drill bushes • Fixture designs
5	**Week 9-10**	• Tooling, requirements of a tool designer, general tool design procedure. • Design of single point lathe tool, Design of shank dimension using strength and rigidity considerations for rectangular, square and round cross section and

		selection of tool geometry. • Drill bit design of elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry • Design of elements like number of teeth and height circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry
6	**Week 11-12**	• Classification and working of power presses • Concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die • Centre of pressure, and strip layout. Simple, progressive, compound, combination and inverted dies. Design problems on blanking and piercing dies for simple components. • Bending dies - Introduction, bend allowance, spring back, edge bending die design. • Drawing dies - Single action, double action and triple action dies, factors affecting drawing and drawing die design.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	Lecture Method	Utilize Chalk and talk lecture format to reinforce competencies.
2	Video/Animation	Incorporate visual aids like videos/animations to enhance understanding the fundamentals of manufacturing and tooling concepts.
3	Collaborative Learning	Encourage collaborative learning through groups for improved competency application.
4	Problem-Based Learning (PBL)	Implement PBL to enhance analytical skills and practical application of competencies
5	Multiple Representations	Introduce topics in various representations like verbal, graphical and mathematical representations to reinforce 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	Socratic Questioning	Pose questions like what? Why? Is it true? Is that the only way? to stimulate critical thinking among students and encourage meaningful discussions

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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 the fundamentals	Students will be able to identify and describe the components and terminology associated with dies, such as core, cavity, and sprue.
2	Designing of cutting tools	Students will be able to design single-point and multi-point cutting tools based on simple design procedure and materialistic characteristics
3	Proficiency in die and mold selection	Students will be able to analyze and solve design problems related to blanking and piercing dies for simple components and decide the selection of type od mold and die required for different types of products
4	Quality issues	Students will be able to implement quality control measures to inspect and ensure the precision of die-casting components, molds and cutting tools resulting in economic aspects of manufacturing
5	Collaboration and Communication Skills	Students will work collaboratively in teams during group discussion session and assignment work, 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
M23BME407B.1	Apply the acquired knowledge of dies, mold and cutting tools to interpret their operations and differentiate them
M23BME407B.2	Infer the fundamentals of cutting tools and tool holder designation system
M23BME407B.3	Analyze jigs and fixtures for any given simple component
M23BME407B.4	Analyze the effects of press tools on different types of dies
M23BME407B.5	Design the single point and multi point cutting tools based on geometrical configurations

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME407B.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407B.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407B.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME407B.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME407B.5	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
M23BME407B	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**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**

Conditions for SEE Paper Setting:
Each module of SEE question paper should be allocated with questions for 20% of the total SEE marks

10. Future with this Subject

The "Die, Mold & Tool Engineering" course in the third semester of the B.E program for Mechanical Engineering 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 manufacturing sciences, production, supply chain management and related ones. Here are some notable contributions:

- Additive Manufacturing (3D Printing): The adoption of 3D printing for producing molds and dies is increasing. This technology allows for more complex geometries, reduced lead times, and cost savings, especially for small production runs and prototyping.
- CNC Machining: Advances in CNC (Computer Numerical Control) machining continue to enhance precision, speed, and efficiency in die and mold making.
- Automation and Robotics: The integration of robotics and automation in manufacturing processes improves consistency, reduces human error, and enhances productivity.
- Advanced Materials: The development of new materials, such as high-strength alloys, composites, and temperature-resistant polymers, is expanding the capabilities of molds and dies, allowing for longer life cycles and better performance under extreme conditions.
- Coatings and Surface Treatments: Improved coatings and surface treatments can extend the lifespan of tools and molds by providing better wear resistance and reducing friction.
- IoT and Smart Manufacturing: The Internet of Things (IoT) enables real-time monitoring and data collection from manufacturing equipment. This data can be used for predictive maintenance, optimizing processes, and reducing downtime.
- Simulation and Virtual Testing: Advanced simulation software allows engineers to test and optimize tool designs virtually before physical production, reducing development time and costs.
- Eco-friendly Materials: The use of biodegradable and recyclable materials is gaining traction as companies strive to reduce their environmental footprint.
- Energy Efficiency: Innovations aimed at reducing energy consumption in manufacturing processes are becoming more important as companies aim to meet stricter environmental regulations and reduce costs.
- Outsourcing and Offshoring: While some aspects of mold and tool production are outsourced to countries with lower labor costs, there is also a trend towards reshoring and localizing production to mitigate risks associated with global supply chains.
- Customization and Short Lead Times: Increasing demand for customized products and shorter lead times is driving the need for more agile and flexible manufacturing solutions.
- Skill Development: There is a growing need for a skilled workforce adept at using advanced technologies. Educational programs and training initiatives are evolving to equip future engineers with the necessary skills.
- Collaboration with Academia: Partnerships between industry and academic institutions are fostering innovation and providing a pipeline of talent to the industry.
- Overall, the future of die, mold, and tool engineering is bright, with technological advancements and innovative practices driving the industry forward. Companies that embrace these changes and invest in new technologies will likely maintain a competitive edge in the global market.

4th Semester	Engineering Science Course (ESC) MEMS- MICRO ELECTRO MECHANICAL SYSTEMS	M23BME407C

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Manufacturing process**	Understanding of manufacturing process. Knowledge of various manufacturing processes such as machining, welding, casting, forging, and additive manufacturing.
2	**Basic machining operations**	Understanding of various machining processes such as turning, milling, drilling, grinding, and boring. Knowledge of cutting tools and their properties, including tool materials, geometry, and coatings
3	**Mathematics**	Proficiency in calculus, linear algebra, differential equations.
4	**Material Science**	Understanding of different materials used in machining, including metals, plastics, and composites. Knowledge of material properties and how they affect machining operations
5	**Metrology and measurement**	Understanding the basic concepts of measurement systems and units (SI units). Knowledge of metrology (the science of measurement) and precision measurement tools and techniques.
6	**System modeling**	Understanding various components and their interactions to predict the behavior and performance of the system. Knowledge about different types of elements (mechanical, electrical, fluid and thermal systems) and how they can be modeled.
7	**Fundamentals of mechanical systems**	Knowledge about prime movers (linear and rotational actuators) and their functions. Understanding the basics of various mechanisms and how these linked to form larger mechanical systems.
8	**Fundamentals of electrical systems**	Understanding of resistors, capacitors, inductors, transformers, semiconductors. Knowledge of AC/DC circuits, power systems, and electrical machines.
9	**Basics of sensors and actuators**	Knowledge of different sensors and actuator types. Understanding of how sensors convert physical phenomena into electrical signals and how actuators convert electrical signals into physical motion.
10	**Basics Optics**	Understanding of basic optical principles such as reflection, refraction, diffraction, and interference. Knowledge of lenses, mirrors, optical fibers, and other optical components.

2. Competencies

S/L	Competency	KSA Description
1	**Production, Precision and Ultra Precision Engineering**	**Knowledge:** Understanding modern manufacturing, specific techniques, technologies, and applications. **Skills:** Designing machines, fixtures, and other structures that have exceptionally low tolerances. **Attitudes:** Appreciation for the role of quality engineers in production, precision and ultra-precision engineering.
2	**Micromachining**	**Knowledge:** Understanding precision manufacturing process that involves the creation of small and intricate features on materials. **Skills:** Gain skills in process optimization, quality control, and the use of CAD/CAM software for designing and programming micromachining processes. Deep understanding of various micromachining techniques and material properties **Attitudes:** Ability to machine components with extremely tight tolerances and high precision
3	**System Modeling**	**Knowledge:** Understanding basic modeling elements that are present in mechanical,

		electrical, fluid and thermal systems. **Skills:** Design of mechanical, electrical, fluid and thermal systems with basic elements. **Attitudes:** Valuing the importance of designing and integrating these basic modeling elements.
4	**Mechanical sensors and actuators**	**Knowledge:** Understanding the principle of sensors and actuators. **Skills:** Design, analyze, and implement sensor and actuator systems for precise control and measurement in various mechanical and industrial applications. **Attitudes:** Emphasizing precision, innovation, and a problem-solving approach to optimize mechanical and industrial systems.
5	**Micro-Opto-Electro Mechanical Systems**	**Knowledge:** Understanding fundamental principles of micro-opto electro mechanical systems. **Skills:** Designing and implementing miniature devices that integrate optical, electrical, and mechanical functionalities with precision and efficiency. **Attitudes:** Proficiency in MOEMS involves the ability to address challenges related to miniaturization, precision engineering, and interdisciplinary collaboration to develop innovative solutions for various technological applications.

3. Syllabus

MEMS - MICRO ELECTRO MECHANICAL SYSTEMS SEMESTER – IV			
Course Code	**M23BME407C**	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:
1. Students are exposed to the MEMS technology & Miniaturization.
2. Students will understand the Process of Micro fabrication Techniques.
3. Students are made to understand the principles of system modeling.
4. Students are made to understand the working principles of Mechanical sensors and actuators.
5. Students are made to understand the working principles of Micro-Opto-Electro Mechanical Systems.

Module -1

MEMS: Introduction, Production Engineering, Precision Engineering and Ultra- Precision Engineering, Integrated circuits, Micro Electro Mechanical Systems.

Module -2

Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA.

Module -3

System Modeling: Introduction, Need for Modeling, System types, Basic Modeling Elements In Mechanical System, Basic Modeling Elements In Electrical Systems, Basic Modeling Elements In Fluid Systems and Thermal Systems.

Module -4

Mechanical sensors and actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements.

Module -5

Micro-Opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror Device.

Text Books:
1. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
2. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat,V.K.Aatre,Wiley India 2010.

Reference Books:
1. Design and Development Methodogies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
2. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: **Introduction, Production Engineering, Precision Engineering and Ultra- Precision Engineering**	Introduction to manufacturing process. Construction and working of production engineering, precision engineering and ultraprecision engineering. Advantages and disadvantages Integrated circuits (integration of microelectronic circuits with mechanical components at a microscale) Introduction to MEMS and microsystems. Understand the definition, history, and evolution of MEMS technology.
2	Week 3-4: **Micromachining**	Introduction to micromachining. MEMS fabrication techniques. Explain photolithography and etching techniques. Explain bulk micromachining and surface micromachining techniques. Difference between bulk versus surface micromachining.
3	Week 5-6: **System Modeling**	Basics of system modeling. Need for system modeling Types of systems Basic Modeling Elements in Mechanical System Basic Modeling Elements in Electrical Systems Basic Modeling Elements in Fluid Systems and Thermal Systems.
4	Week 7-8: **Mechanical sensors and actuators**	Introduction to sensors and actuators Principles of sensing and actuation. Different types of MEMS sensors and their working principles Different types of MEMS actuators and their working principles. Piezo Electric Material as Sensing and Actuating Elements.
5	Week 9-10: **Micro-Opto-Electro Mechanical Systems**	Introduction to MOEMS Fundamental principles of MOEMS technology Review on Properties of Light Light Modulators Micro mirrors Digital Micro mirror Device.
6	Week 11-12:	Apply learned concepts and competencies to real-world scenarios.

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 MEMS 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

6. Assessment Details (both CIE and SEE)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

5) 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.
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	Fundamental concepts of MEMS	Students will learn about different the properties of materials chosen for MEMS design, such as silicon, polymers, and metals.
2	Fundamentals of advanced manufacturing techniques	Students will able to understand and apply advanced manufacturing techniques to achieve high levels of accuracy and precision in the production of components.
3	Fundamentals of microfabrication techniques and materials	Students will learn about design and fabricate micro-scale devices using various micromachining techniques.
4	Fundamentals of mechanical sensors and actuators	Students will understand the working principles of different types of MEMS sensors (e.g., pressure sensors, accelerometers) and actuators (e.g., microvalves, micromotors).
5	Fundamentals of system modeling	Students will understand how different components of a system interact and influence overall behavior.
6	Fundamentals of MOEMS	Students will understand how studying MOEMS enables the integration of optical, mechanical, and electronic components at the microscale, thereby advancing innovations in fields such as telecommunications, medical devices, and sensing technologies.

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

Course Outcomes (COs)

COs	Description
M23BME407C.1	Demonstrate a thorough understanding of MEMS principles, fabrication techniques, and materials.
M23BME407C.2	Apply micro fabrication techniques such as photolithography, etching, and wafer bonding to manufacture MEMS components.
M23BME407C.3	Understand the fundamental principles of mechanical, electrical, fluid, and thermal systems and Develop mathematical models to represent the behavior of these systems.
M23BME407C.4	Analyze and integrate sensors, actuators, and other components into MEMS systems
M23BME407C.5	Understanding the principles and applications of Micro-Opto-Electro-Mechanical Systems (MOEMS), including the properties of light, light modulators, micro mirrors, and Digital Micro Mirror Devices (DMDs).

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME407C.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407C.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407C.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407C.4	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME407C.5	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME407C	**3**	**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 "MEMS- 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 MEMS. Here are some notable contributions:

- **Integration of Disciplines**: MEMS education combines principles from mechanical engineering, electrical engineering, materials science, and computer science, offering a comprehensive understanding of how these fields intersect.
- **Prototyping and Design**: Students learn about the design and prototyping of micro-scale devices, which are valuable skills in various engineering and technology fields.
- **Exposure to Cutting-Edge Tech**: Students studying MEMS are exposed to advanced technologies such as nanotechnology, biotechnology, and materials science, keeping them at the forefront of technological advancements.
- **Interdisciplinary Projects**: Students often have the opportunity to work on interdisciplinary projects, collaborating with peers from different fields and enhancing their teamwork and communication skills.
- **Healthcare Innovations**: Students can contribute to the development of medical devices and diagnostic tools that improve healthcare outcomes.
- **Environmental Monitoring**: MEMS technology can be used to develop sensors for environmental monitoring, helping to address issues such as pollution and climate change.

4th Semester	Engineering Science Course (ESC) ROBOTICS AND AUTOMATION	M23BME407D

1. Prerequisites

S/L	Proficiency	Prerequisites; Enrolling in an automation and robotics course typically requires a foundation in several key areas. the following are common prerequisites:
1	Mathematics	**Calculus:** Understanding of differentiation and integration, which are fundamental for modeling and analyzing dynamic systems. **Linear Algebra:** Knowledge of vectors, matrices, and linear transformations, which are essential for robotics kinematics and dynamics. **Differential Equations:** Ability to solve ordinary differential equations, crucial for system modeling and control.
2	Physics	**Mechanics:** Basic understanding of Newtonian mechanics, which is essential for understanding robot dynamics and motion. **Electromagnetism:** Knowledge of basic principles, as the course includes robotics sensors and actuators.
3	Basic Electrical and Electronics Engineering	Basic understanding of electrical drives, microcontrollers and microprocessors and programming
4	Basic Computer Science and Engineering	Understanding Of computer vision and basic programming proficiency
5	Mechanical Engineering	Study of motion without considering forces. Forward and inverse kinematics is crucial for robot arm manipulation. Study of forces and torques in robot motion.

2. Competencies

S/L	Competency	KSA Description
1	Mathematics	**Knowledge:** Advanced understanding of calculus, linear algebra, and differential equations. **Skills:** Applying mathematical models to simulate and optimize robotic performance. **Attitudes:** Continuously learning and improving
2.	Mechanical Engineering	**Knowledge:** Robotics Mechanisms, Actuators, and Sensors **Skills:** Creating and interpreting schematics, diagrams, and technical documentation **Attitudes:** Quickly adapting to new tools, technologies, and methodologies
3.	Interdisciplinary	**Knowledge:** Recognize that there are many ways to think about and develop 'intelligent' machines. **Skills:** Identify a variety of technologies that use programming, including technology spanning cognitive systems, controllers and ML **Attitudes:** Identify when to use a range of interdisciplinary methods across the breadth of the field
4.	Pedagogical Knowledge	**Knowledge:** Understanding of educational theories and practices relevant to teaching STEM subjects. **Skills:** Skills in designing, building, and troubleshooting robotic systems and components. **Attitudes:** Commitment to ongoing professional development and staying updated with the latest advancements in robotics and education.

3. Syllabus

AUTOMATION AND ROBOTICS SEMESTER – IV			
Course Code	**M23BME407D**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(3:0:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

OVERVIEW: In near future, robots will be used widely in the fields of manufacturing, medicine, search and rescue, service, and entertainment. So, it is very much important to teach robotics as the synergistic integration of mechanics, electronics, controls and computer science. This subject is intended to make students aware with basics of robot sensors, controls, transformations along with essential kinematics and dynamics, robot programming language and Industrial automation system

Module -1	
AUTOMATION: Definition, Types of automation, Basic elements of an automated system, advanced automation functions, levels of automation, and process industries versus discrete manufacturing industries, continuous versus discrete control computer process control and its capabilities and fundamentals of Industry 4.0.	L1, L2, L3
Module -2	
FUNDAMENTALS Of ROBOTICS: Definition and origin of robotics – Asimov's laws of robotics - different types of robotics – various generations of robots – degrees of freedom – robot anatomy, work volume, geometrical configuration, precision of movement, End effectors- types of grippers and tools.	L1, L2, L3
Module -3	
THE ROBOT AND ITS PERIPHERALS: Robot drive system: hydraulic, electric and pneumatic.. Feedback components: position and velocity sensors. Internal state sensors-encoders, potentiometer and resolver. External state sensor- tactile, proximity and range sensors digitizing function in machine vision- image processing and analysis.	L1, L2, L3
Module -4	
ROBOT MOTION ANALYSIS AND CONTROL: Introduction to manipulator kinematics- Homogeneous transformations and Robot Kinematics- manipulator path control- robot dynamics- configuration of Robot controller- Obstacle avoidance.	L1, L2, L3
Module -5	
ROBOT PROGRAMMING AND ROBOT APPLICATIONS IN MANUFACTURING: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods. Robot applications - material transfer & machine loading/unloading - processing operations – inspection - automation - robot cell design – control – recent developments and special applications.	L1, L2, L3

Text Books:

1. Industrial Robotics: Technology, Programming, and Applications by Groover Mikell P,McGraw Hill Education 2nd Edition
2. Automation, Production Systems, and Computer-integrated Manufacturing by Mikell P. Groover, Prentice Hall, 2008

Reference Books:

1. Robotics for Engineers Yoram Koren McGraw Hill International 1st edition, 1985.

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction to automation	Definition, Types of automation, Basic elements of an automated system, advanced automation functions, levels of automation, and process industries versus discrete manufacturing industries, continuous versus discrete control computer process control and its capabilities and fundamentals of Industry 4.0.
2	Week 3-4: Fundamentals of Robotics	Definition and origin of robotics – Asimov's laws of robotics - different types of robotics – various generations of robots – degrees of freedom – robot anatomy, work volume, geometrical configuration, precision of movement, End effectors- types of grippers and tools.
3	Week 5-6: The Robot and Its Peripherals:	Robot drive system: hydraulic, electric and pneumatic. Feedback components: position and velocity sensors. Internal state sensors-encoders, potentiometer and resolver. External state sensor- tactile, proximity and range sensors digitizing function in machine vision- image processing and analysis.
4	Week 7-8:	Introduction to manipulator kinematics- Homogeneous transformations and Robot

	Robot Motion Analysis and Control	Kinematics- manipulator path control- robot dynamics- configuration of Robot controller- Obstacle avoidance.
5	Week 9-10: Robot Programming and Robot Applications In Manufacturing	Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods. Robot applications - material transfer & machine loading/unloading - processing operations – inspection - automation - robot cell design – control – recent developments and special applications
6	Week 11-12:	Revision of the automation and robotics course and Question Papers Review

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
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	Real-World Application	Discuss practical applications to connect theoretical concepts with real-world competencies.
6	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)

Continuous Internal Evaluation:

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 2 test marks conducted.

Semester End Examination

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 industrial automation system fundamentals	Students will grasp the fundamental concepts of industrial automation system, including advanced automation functions, levels of automation, and process industries versus discrete manufacturing industries, continuous versus discrete control computer process control and its capabilities and fundamentals of Industry 4.0.
2	Understanding the fundamentals of robotics and its peripherals	Students will grasp the fundamental concepts robotics which includes Asimov's laws of robotics -various generations of robots – degrees of freedom – robot anatomy, work volume, geometrical configuration, precision of movement, End effectors.
3	Understand the robotic kinematics	Students will become proficient in understanding and analyzing the robotic kinematics and dynamics

	and dynamics	
4	Provide the student with some programming knowledge and applications associated with robot	Students will become proficient in understanding and developing robotic programming for manufacturing applications

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

Course Outcomes (COs)

COs	Description
M23BME407D.1	Classify types of robots and identify its subsystems.
M23BME407D.2	Illustrate an actuator, its gripper/s and sensor for a robot based on given application
M23BME407D.3	Perform kinematic and dynamic analysis of robots
M23BME407D.4	Apply robot programming language in manufacturing environment
M23BME407D.5	Interpret Industrial automation system

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME407D.1	-	3	-	-	-	-	-	-	-	-	-	-	3	-
M23BME407D.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME407D.3	-	3	-	-	-	-	-	-	-	-	-	-	-	3
M23BME407D.4	3	-	-	-	-	-	-	-	-	-	-	-	-	3
M23BME407D.5	3	-	-	-	-	-	-	-	-	-	-	-	3	-
M23BME407D	3	3	-	-	-	-	-	-	-	-	-	-	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 "Automation and Robotics" 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 advanced manufacturing systems. Here are some notable contributions:

Project Work and Research: The learning attributes gained through conceptualization, programming, problem-solving, using robotics course prepares students for more extensive projects in their later years. It equips them with the skills needed for research in the field of automation and advanced manufacturing systems.

In summary, the "Automation and Robotics " 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) INTRODUCTION TO AI & ML	M23BME408A

1. Prerequisites

S/L	Proficiency	Prerequisites
1	Mathematics	A solid understanding of calculus, linear algebra, probability theory, and statistics is essential for understanding the algorithms and models used in AI and ML.
2	Programming	Proficiency in at least one programming language, preferably Python, is important for implementing algorithms and working with libraries commonly used in AI and ML.
3	Computer Science Fundamentals	Knowledge of basic computer science concepts such as algorithms, data structures, and complexity theory is beneficial for understanding the theoretical aspects of AI and ML.
4	Probability and Statistics	A good grasp of probability theory and statistics is crucial for understanding the probabilistic models and inference methods used in AI and ML.
5	Critical Thinking and Problem-Solving Skills	AI and ML involve complex problems that require critical thinking and problem-solving skills to formulate and solve effectively.
6	Previous Coursework	Completion of introductory courses in Programming or a related field

2. Competencies

S/L	Competency	KSA Description
1	**Understanding of AI and ML Concepts**	**Knowledge:** Understanding of the fundamental concepts, principles, and algorithms used in artificial intelligence and machine learning. **Skills:** • Ability to translate real-world problems into AI and ML tasks. • Skill in implementing AI and ML algorithms using programming languages such as Python **Attitudes:** Appreciation for the importance of AI and ML in solving real world problems
2	**Problem-Solving Skills**	**Knowledge:** Understanding the concepts of formulating real-world problems as machine learning tasks. **Skills:** Skills in formulating real-world problems as machine learning tasks and applying appropriate algorithms to solve them. **Attitudes:** Appreciation for the importance of AI and ML in solving real world problems
3	**Programming Skills**	**Knowledge:** Learning the programming languages commonly used in AI and ML, such as Python. **Skills:** Proficient in programming languages commonly used in AI and ML, such as Python, and be able to implement machine learning algorithms and models. **Attitudes:** Valuing the use of programming languages commonly used in AI and ML, such as Python in writing machine learning algorithms
4	**Knowledge of ML Models**	**Knowledge:** Gaining the knowledge of various machine learning models and techniques including supervised learning, unsupervised learning, and reinforcement learning. **Skills:** Ability to select, implements, and evaluate various machine learning models to solve specific problems effectively.

		Attitudes: Valuing the ability to select, implement, and evaluate various machine learning models to solve specific problems effectively
5	**Data Preprocessing**	**Knowledge:** Understanding how to preprocess and clean data to prepare it for training machine learning models. **Skills:** Ability to preprocess and clean data to prepare it for training machine learning models **Attitudes:** Appreciation the Ability to preprocess and clean data to prepare it for training machine learning models

3. Syllabus

INTRODUCTION TO AI & ML SEMESTER – IV			
Course Code	**M23BME408A**	CIE Marks	**50**
Number of Lecture Hours/Week(L: T: P: S)	**(0:0:2:0)**	SEE Marks	**50**
Total Number of Lecture Hours	**15 sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**03**

Course objectives: This course will enable students to:
- Make use of Data sets in implementing the machine learning algorithms
- Implement the machine learning concepts and algorithms in any suitable language of choice
- Analyse the working of various documents like PDF, Word file

SL NO	**Experiments**
1	Implement A* Search algorithm
2	Implement AO* Search algorithm
3	Write a program to implement Water jug program using AI.
4	The probability that it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is Friday is 20 %. What is the probability that a student is absent given that today is Friday? Apply Baye's rule in python to get the result.
5	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
6	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
7	Build an Artificial Neural Network by implementing the Back-propagation algorithm and test the same using appropriate data sets.
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API
Demonstration Experiments (For CIE only – not to be included for SEE) .	
9	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Suggested Learning Resources:

1. Tom M Mitchell,"Machine Lerning",1st Edition, McGraw Hill Education, 2017.
2. 2. Elaine Rich, Kevin K and S B Nair, "Artificial Intelligence", 3rd Edition, McGraw Hill Education, 2017.

4. Syllabus Timeline

S/L	**Syllabus Timeline**	**Description**
1	Week 1-2:	• Implement A* Search algorithm • Implement AO* Search algorithm
2	Week 3-4:	• Write a program to implement Water jug program using AI. • Apply Baye's rule in python to solve simple real time problems
3	Week 5-6:	• Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data

		from a .CSV file • For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
4	Week 7-8:	• Build an Artificial Neural Network by implementing the Back-propagation algorithm and test the same using appropriate data sets. • Write a program to construct a Bayesian network considering medical data.
5	Week 9-10:	• program to demonstrate the working of the decision tree based ID3 algorithm

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 AI-ML concepts.
3	Collaborative Learning	Encourage collaborative learning for improved competency application.
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)

Internal test for laboratory course with software experiments shall be conducted for a total of 100 mark at the end the semester and the assessment pattern.

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

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

SEE marks for practical course shall be 50 marks

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**

1. See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
2. 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 3 hours.

7. Learning Objectives

S/L	Learning Objectives	Description
1	Implement A Search Algorithm	Students will Learn to implement and optimize the A* search algorithm in a programming environment.
2	Implement AO Search Algorithm	Students will learn to Implement the AO* search algorithm and analyze its performance on various problem instances
3	Apply Baye's Rule in Python	Students will able to Understand and apply Baye's theorem to real-world probabilistic inference problems.

4	Implement and Demonstrate the FIND-S Algorithm	Students will develop skills in reading and processing training data from a .CSV file.
5	Implement and Demonstrate the Candidate-Elimination Algorithm	Students will Develop proficiency in implementing the algorithm and processing training data from a .CSV file.

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

Course Outcomes (COs)

COs	Description
M23BME408A.1	**Apply** the implementation procedures for various machine learning algorithms
M23BME408A.2	**Apply** Python programming skills to implement various learning algorithms
M23BME408A.3	**Apply** appropriate data sets to the Machine Learning algorithms
M23BME408A.4	Identify and **apply** Machine Learning algorithms to solve real world problems
M23BME408A.5	**Apply** knowledge of the working principles of PDF and Word file formats to effectively create, edit, and manage documents in both formats

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME408A.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
M23BME408A.2	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME408A.3	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
M23BME408A.4	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME408A.5	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME408A	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Program	**08**	**08**	**08**	**08**	**08**	**40**
Viva	**02**	**02**	**02**	**02**	**02**	**10**
Total	**10**	**10**	**10**	**10**	**10**	**50**

Semester End Examination (SEE)

	CO1	CO2	CO3	CO4	CO5	**Total**
Program	**16**	**16**	**16**	**16**	**16**	**80**
Viva	**04**	**04**	**04**	**04**	**04**	**20**
Total	**20**	**20**	**20**	**20**	**20**	**100**

The SEE 100 marks is scaled down to 50 marks

10. Future with this Subject

The "Introduction to AI and ML "course in the fourth semester of the B.E program provides a strong foundation for engineering courses by introducing fundamental concepts essential for modern technology. Understanding AI and ML principles enhances problem-solving skills, enabling engineers to develop innovative solutions across various disciplines. It also prepares students for advanced topics in robotics, automation, and data science, which are increasingly integral to engineering practices. Mastery of these concepts equips engineers with the tools needed to tackle complex real-world challenges effectively.

4th Semester	Ability Enhancement Course (AE) DIGITAL MARKETING	M23BME408B

1. Prerequisites

S/L	Proficiency	Prerequisites
1	**Digital Literacy**	understanding of the digital landscape, including social media platforms, search engines, and basic online communication tools, will be necessary.
2	**Data Analysis**	The ability to interpret basic data and draw insights will be crucial for understanding campaign performance in digital marketing.
3	**Writing Skills**	Clear and concise writing is essential for crafting content marketing for various digital channels
4	**Visual Communication**	Basic understanding of visual design principles will be beneficial for creating engaging visuals for social media and other marketing materials.
5	**Customer Journey and Targeting**	Identify different stages of the customer journey online and develop targeted marketing strategies for each stage.
6	**Digital Marketing Channels**	Knowledge on popular social media platforms and their functionalities for marketing purposes. Create and manage basic social media content calendars.
7	**Marketing Analytics**	Interpret basic website analytics data to understand audience demographics, traffic sources, and campaign performance
8	**Communication and Storytelling**	Knowledge on Craft compelling and concise content that resonates with the target audience.

2. Competencies

S/L	Competency	KSA Description
1	**Traditional Marketing Foundation**	**Knowledge:** Core marketing principles 4Ps (i.e. product, price, Place & Promotion) and Identifying the target audience. **Skills:** Analyze traditional marketing campaigns (strengths & weaknesses). **Attitude:** Appreciate the value of traditional marketing as a foundation
2	**Fundamentals of marketing**	**Knowledge:** Understands the core marketing mix (product, price, place, promotion) in a digital context. Recognizes the importance of customer segmentation and targeting in digital marketing. Grasps the concept of the marketing funnel and its application in online marketing strategies. **Skills:** Able to Applies basic principles of digital marketing to improve online visibility. Creates engaging content (text, images, videos) for targeted audiences on digital platforms. Utilizes social media marketing tools and strategies to promote products or services. **Attitude:** Demonstrates a data-driven approach to digital marketing, analyzing results and optimizing campaigns.
3	**Digital Marketing Landscape**	**Knowledge:** Understanding of core digital marketing concepts like SEO, SEM, social media marketing, content marketing, and email marketing. Ability to identify the target audience for a mechanical engineering product or service and their online behavior. **Skills:** Content creation skills for technical topics, including writing blog posts, social media captions, and email newsletters. Proficiency in social media marketing platforms like LinkedIn, YouTube, and

		industry-specific platforms. Data analysis skills to measure campaign performance and identify areas for improvement. **Attitude:** Problem-solving skills to develop effective marketing campaigns for a technical audience. Strong communication and interpersonal skills to engage with potential customers online.
4	**Social media marketing platforms**	**Knowledge:** Understanding of social media algorithms and analytics (e.g., how content reaches users, key performance indicators). Familiarity with various social media platforms and their functionalities (e.g., understanding strengths and weaknesses of each platform) **Skills:** Skill in content creation for social media platforms (e.g., crafting compelling visuals, tailoring messages for different platforms). Ability to measure and analyze social media performance (e.g., tracking engagement metrics, interpreting data). **Attitude:** Adaptability to changing trends and technologies in digital marketing (e.g., embracing new platforms, staying updated on algorithms) A collaborative and results-oriented mindset (e.g., working effectively with teams, focusing on achieving campaign goals).
5	**Digital marketing channels**	**Knowledge:** Functioning of search engines and ranking algorithms - Keyword research and optimization techniques. Understanding of Content creation strategies tailored for social media platforms. **Skills:** Able to Perform keyword research and analysis - Optimize website content for search engines. Able to Create engaging social media content (text, images, videos) - Manage and schedule social media posts. **Attitude:** Analytical thinking to understand search trends - Adaptability to keep up with evolving SEO best practices. Creativity to develop compelling content - Communication skills to engage with followers.
6	**Branding**	**Knowledge:** Identify and leverage relevant digital channels to build brand awareness for engineering products/services. **Skills:** Develop and implement content marketing strategies (e.g., blog posts, case studies) that position an engineering brand as an industry leader. **Attitude:** Focus on building a strong online reputation for the mechanical engineering product/services.
7	**Marketing Analytics**	**Knowledge:** Fundamentals of digital marketing channels (Social Media, SEO, SEM, Content Marketing, Email Marketing). Metrics and data analysis relevant to digital marketing campaigns (e.g., website traffic, conversion rates, customer engagement) Skills: Utilize marketing analytics tools to track campaign performance and make data-driven decisions. Develop and implement basic digital marketing campaigns **Attitude:** Analytical mindset with a focus on data interpretation and continuous improvement

3. Syllabus

DIGITAL MARKETING **SEMESTER – IV**			
Course Code	**M23BME408B**	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 Sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**01**
Examination nature (SEE)	**Theory**		
Course Objective: • To focuses on the importance of digital marketing and its applications. • Introduce current and core practices of Digital and Social Media Marketing that will allow learners to analyse, plan, execute and evaluate a digital marketing strategy**.**			
Module 1			
Introduction to Digital Marketing (DM)-Meaning, Definition, Need of DM, Scope of DM, History of DM, Concept and approaches to DM, Examples of good practices in DM. Email Marketing-Need for Emails, Types of Emails, options in Email advertising.			L1, L2 L3
Module-2			
Social Media Marketing -Introduction to Blogging. Introduction to Face book, Twitter, Google Ads, LinkedIn, YouTube Instagram and Pinterest; their channel advertising and campaigns.			L1, L2 L3
Module 3			
Acquiring & Engaging Users through Digital Channels: Understanding the relationship between content and branding and its impact on sales, search engine marketing, mobile marketing, video marketing, and social-media marketing			L1, L2 L3
Module 4			
Web Analytics: Introduction to web analytics, importance of web analytics, traditional vs digital marketing analytics, creating measurement framework, mapping marketing objectives for the consumer funnel and common tools used for analytics.			L1, L2 L3
Module 5			
Case Studies: Social media platforms like Email marketing, search engine marketing, social media marketing and its analysis with various digital marketing tools such as SEO, SMM and web analytics.			L1, L2 L3
Text Books: **1.** Fundamentals of Digital Marketing by Puneet Singh Bhatia, Pearson **2.** Moutsy Maiti: Internet Marketing, Oxford University Press India **3.** Vandana, Ahuja; Digital Marketing, Oxford University Press India (November, 2015). **4.** Eric Greenberg, and Kates, Alexander; Strategic Digital Marketing: Top Digital Experts **5.** Share the Formula for Tangible Returns on Your Marketing Investment; McGraw-Hill Professional (October, 2013). **Reference Books** 1. Ryan, Damian; Understanding Digital Marketing: marketing strategies for engaging the digital generation; Kogan Page (3rd Edition, 2014). 2. Tracy L. Tuten & Michael R. Solomon: Social Media Marketing (Sage Publication) 3. Digital Marketing: Strategy, Implementation & Practice by Dave Chaffey and Fiona EllisChadwick 4. Digital Marketing: Strategy, Implementation & Practice By ave Chaffey & Fiona Ellis-Chadwick.			

4. Syllabus Timeline

S/L	Syllabus Timeline	Description
1	Week1-2	• Definition and need of Digital Marketing. • History and Scope of Digital Marketing. • Concept and approaches to DM, Examples of good practices in DM. • Email Marketing-Need for Emails & Types of Emails. • Email advertising.
2	Week 3-4:	• Introduction to Blogging. • Introduction to Face book, Twitter, Google Ads, LinkedIn, YouTube Instagram and Pinterest;
3	Week 5-6	• Digital channels advertising and campaigns. • Digital channels advertising and campaigns. • Understanding the relationship between content and branding and its impact on sales.
4	Week 7-8	• Search engine marketing, mobile marketing.

		• Video marketing, and social-media marketing
5	Week 9-10:	• Introduction to web analytics, importance of web analytics, • Traditional vs digital marketing analytics. • Creating measurement framework, mapping marketing. • objectives for the consumer funnel and • common tools used for analytics.
6	Week 11-12	• **Social media platforms like Email marketing, search engine marketing.** • **Social media marketing and its analysis with various digital marketing tools** such as SEO, SMM and web analytics.

5. Teaching-Learning Process Strategies

S/L	TLP Strategies:	Description
1	**Lecture & Discussion**	Utilize chalk & Talk teaching methods within the lecture format to reinforce competencies.
2	**PowerPoint presentations and**	Integrate charts, graphs, and compelling images to represent complex marketing concepts in a clear and engaging way. Showcase how established engineering companies leverage digital marketing to promote their products and services.
3	**Video demonstrations**	Short video clips/ animations enhance understanding of complex marketing concepts and transform passive learning into active participation. video can be reviewed at your own pace, allowing you to revisit key takeaways and solidify your learning
4	**Adopt flipped classroom teaching method**	Utilize a flipped class approach, providing materials before class to facilitate deeper understanding of competencies
5	**Adopt collaborative (Group Learning) learning in the class.**	Small groups on projects that simulate real-world digital marketing scenarios for mechanical engineering products or services.
6	**Case studies**	Case studies showcase how companies reach target audiences and Promote products/services. Analyzing case studies encourages students to think critically. They evaluate marketing strategies, identify strengths and weaknesses, and consider alternative approaches.

6. Assessment Details (both CIE and SEE)

Final CIE for Theory based Ability Enhancement Course

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 (A+B)			**50**	**20**

1. The CIE question paper shall have MCQ set for 25 questions, each carrying one mark.
2. 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 of Traditional marketing**	• To Identify common traditional marketing channels like print, television, radio, and billboards. • Analyze the advantages and limitations of traditional marketing for reach, and measurability.
2	**Digital marketing strategies**	• Students will Explore the various digital marketing channels like social media, search engine optimization (SEO), email marketing, and content marketing and how it can be applied to reach potential clients and showcase the value proposition of mechanical engineering solutions
3	**Core practices of social media marketing**	• To Identify major social media platforms (Facebook, Twitter, Instagram, LinkedIn etc.) and their functionalities. • Analyze the strengths and weaknesses of each platform for promoting engineering products and services.

4	**Search Engine Optimization (SEO)**	• Able to understand how search engines work. - Apply SEO principles to improve website ranking for relevant engineering terms. • Analyze keyword research for targeting potential clients in the engineering sector.
5	**Content Marketing (e.g., Blogs, Articles)**	• Students able to create informative and engaging content related to mechanical engineering topics. • Understand content strategy for attracting and educating target audiences
6	**Email Marketing**	• Students will able to build targeted email lists for specific engineering audiences. - Craft compelling email campaigns to nurture leads or promote engineering services.

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

Course Outcomes (COs)

COs	Description
M23BME408B.1	Make use the fundamentals of Digital marketing to explain its role & concepts of Email marketing to improve the effectiveness of advertisement & conversion rate.
M23BME408B.2	Utilize concepts of Digital Marketing Campaigns using various social media marketing platforms and measure their effectiveness
M23BME408B.3	Apply various Digital marketing techniques to optimize the blog in real world situations and Distinguish among content & Branding.
M23BME408B.4	Use website analytics to improve the effectiveness of advertisement and conversion rate
M23BME408B.5	Demonstrate case studies with appropriate digital marketing tools such as SEO, SMM to various social media marketing platforms in real world situations

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME408B.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME408B.2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME408B.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME408B.4	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
M23BME408B.5	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
M23BME408B	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

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

10. Future with this Subject

The world of engineering is rapidly evolving, and the ability to effectively market your skills and knowledge is more crucial than ever. This course, "Digital Marketing for Mechanical Engineering," equips you with the essential tools and strategies to navigate the digital landscape and propel your future in the industry.

a) **Broaden your career options:** The digital marketing field is booming. By understanding online marketing strategies, you can position yourself for roles in marketing for engineering firms, 3D printing companies, or even pursue freelance opportunities.

b) **Enhance your marketability:** Even if you pursue a traditional mechanical engineering career path, having digital marketing skills can make you a more attractive candidate. You'll be able to understand how to effectively communicate the value of engineering products and services to a wider audience.

c) **Become an Entrepreneur:** If you're passionate about a specific engineering innovation, digital marketing knowledge can empower you to champion its adoption within your company or even launch your own venture.

d) **Master the art of storytelling:** Digital marketing is all about crafting compelling narratives. This skill translates well to engineering fields, where clear and concise communication is key for project proposals, presentations, and user manuals.

4th Semester	Ability Enhancement Course (AE) INTRODUCTION TO DATA ANALYTICS	M23BME408C

1. Prerequisites:

S/L	Proficiency	Prerequisites
1	Programming Fundamentals	Ability to write simple Python programs, understand control flow, and use basic data structures (lists, dictionaries).
2	Basic Mathematics	Familiarity with mathematical operations, basic understanding of concepts like mean, median, and standard deviation
3	Data Fundamentals	What is data? - Types of data (structured, unstructured, semi-structured) Data collection methods
4	Problem-Solving Skills	Comfortable with approaching problems logically and creatively, identifying key elements and potential solutions.
5	Software Usage	Ability to navigate file systems, install and run software, and manage data files efficiently.
6	Previous Coursework	Completion of introductory courses in python or a related field

2. Competencies:

S/L	Competency	KSA Description
1	Data Literacy	**Knowledge:** Types of data (structured, unstructured, semi-structured) Data collection methods Data quality issues **Skills:** Identify data types from various sources. Explain data collection methods for different scenarios. Recognize potential data quality problems. **Attitudes:** Curiosity to explore data and uncover insights. Openness to learning from data.
2	Data Manipulation	**Knowledge:** Data cleaning techniques (missing values, outliers) Descriptive statistics **Skills:** Clean and prepare data for analysis using relevant techniques. Calculate and interpret descriptive statistics (mean, median, mode, etc.). **Attitudes:** Attention to detail for accurate data handling. - Problem-solving skills to address data inconsistencies.
3	Data Visualization	**Knowledge:** Data visualization tools (Matplotlib) Chart types for different data representations **Skills:** Create informative visualizations (histograms, scatter plots, etc.) to present data effectively. Choose appropriate chart types based on data characteristics. **Attitudes:** Creativity in presenting data in a clear and concise manner. Ability to communicate findings visually
4	Programming Fundamentals	**Knowledge:** Python basics (variables, data types, control flow) **Skills:** Write basic Python programs to automate data tasks. Utilize control flow statements for data manipulation. **Attitudes:** Analytical thinking to break down problems into logical steps. Persistence in learning new programming concepts.
5	Libraries for Data Science	**Knowledge:** Pandas data structures (Series, DataFrame)

		Skills: Work effectively with Pandas for data cleaning, transformation, and analysis. Perform aggregations and calculations on data using Pandas functions. **Attitudes:** Adaptability to learn new tools and libraries. Willingness to experiment and explore functionalities.
6	Machine Learning Concepts	**Knowledge:** Supervised vs unsupervised learning Common machine learning algorithms **Skills:** Describe the basic principles of popular machine learning algorithms (linear regression, decision trees). Evaluate the performance of machine learning models using basic metrics (accuracy, precision, recall). **Attitudes:** Intellectual curiosity to explore the potential of machine learning. Openness to new approaches and technologies for data analysis.
7	Probability & Statistics	**Knowledge:** Probability concepts - Sampling techniques Sampling distributions - Measures of central tendency and dispersion **Skills:** Apply probability concepts to analyze data uncertainty. Implement different sampling techniques for data collection. Calculate and interpret measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation). **Attitudes:** Critical thinking to evaluate data based on statistical principles. Comfort with quantitative analysis and interpreting results.

3. Syllabus:

INTRODUCTION TO DATA ANALYTICS **SEMESTER – IV**			
Course Code	**M23BME408C**	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 Sessions**	Total Marks	**100**
Credits	**01**	Exam Hours	**02**

Course objectives: This course will enable students to:

- To master data manipulation using Python structures and libraries (NumPy, Pandas) for analysis.
- To build statistical foundations by developing a strong understanding of core concepts for data summarization, analysis, and pattern discovery.
- To explore machine learning algorithms through introductory knowledge of decision tree and random forest algorithms for classification tasks.
- To craft data visualizations by leveraging Matplotlib to create informative and impactful visualizations for data communication.
- To develop analytical expertise by cultivating critical thinking, problem-solving skills, and team collaboration to effectively approach data-driven challenges.

Experiments	
1.	Use Numpy to create single and multi-dimensional array and perform various operations using Python.
2.	Use Pandas to access dataset, cleaning, manipulate data and analyze using Python
3.	Use matplot library to plot graph for data visualization using Python
4.	Determine probability, sampling and sampling distribution using Python
5.	Determine frequency distributions, variability, average, and standard deviation using Python
6.	Draw normal curves, correlation, correlation coefficient and scatter plots using Python
7.	Implement and analyze Linear regression in Python (Single variable & Multivariable)
8.	Implement and analyze Logistic regression in Python
Demonstration Experiments (For CIE only – not to be included for SEE)	
1.	Implementation of two samples T-test and paired two-sample T-test in excel. 12 Implementation of one-way and two-way ANOVA in excel.

➢ McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".

- Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
  Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. "John Wiley & Sons, Inc"
- https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python
- https://www.youtube.com/watch?v=GPVsHOlRBBI&ab_channel=freeCodeCamp.org

4. Syllabus Timeline:

S/L	Syllabus Timeline	Description
1	Week 1-2: Introduction and Experiment -01	Introduction to Data Analytics and refreshing the concepts of Python. Perform various operations using Python (Numpy Library)
2	Week 3-4: Experiment-2 & Experiment-3	Make Use of Pandas to access dataset, cleaning, manipulate data. Utilize matplot library to plot graph.
3	Week 5-6: Experiment-4 & Assessment-01	With the help of Python learning the concepts of probability, sampling and sampling distribution. Assessment-01 to be scheduled after the completion of 4 experiments.
4	Week 7-8: Experiment-5 & Experiment-6	Using Python determine frequency distributions, variability, average, and standard deviation Learn to Draw normal curves, correlation, correlation coefficient and scatter plots using Python
5	Week 9-10: Experiment-7 & Experiment-8	Implement and analyze Linear regression in Python. Implement and analyze Logistic regression in Python
6	Week 11-12: Demonstrations Experiments and Assessment - 02	Implementation of two samples T-test and paired two-sample T-test in excel. Assessment-02 to be scheduled after the completion of all experiments.

5. Teaching-Learning Process Strategies:

S/L	TLP Strategies:	Description
1	Lecture/Demonstration	Utilize various teaching methods to explain concepts and demonstrates code examples.
2	Practice-based Learning	Focus on coding practice through exercises, challenges, and projects to solidify understanding.
3	Break down Complex Topics	Present complex topics in smaller, manageable steps with clear explanations.
4	Problem-Based Learning	Implement PBL to enhance analytical skills and practical application of competencies
5	Multiple Representations	Introduce topics in various representations to reinforce 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):**

Internal test for laboratory course with software experiments shall be conducted for a total of 100 marks at the end the semester and the assessment pattern.

Marks distribution for Program based Practical Course for CIE

Sl. No.	Description	% of Marks	In Marks
1	Observation, write-up, algorithm/program/execution	80% of the maximum	80
2	Viva-Voce	20% of the maximum	20
Total		100%	100

Marks scored by the student for 100 are scaled down to 50 marks.

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

SEE marks for practical course shall be 50 marks

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**

1. See for practical course is evaluated for 100 marks and scored marks shall be scaled down to 50 marks.
2. 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 3 hours.

7. **Learning Objectives:**

S/L	Learning Objectives	Description
1	Master data manipulation with Python	Student will be able to use Python data structures and libraries (NumPy, Pandas) to effectively organize, clean, and transform data for analysis.
2	Develop a strong foundation in statistics	Students will gain a solid understanding of core statistical concepts and be able to apply them to summarize, analyze, and uncover patterns within data.
3	Craft impactful data visualizations	Students will learn to create informative and visually appealing charts and graphs using Matplotlib to effectively communicate data insights.
4	Integrate Excel strategically for data analysis	Students will understand the strengths and limitations of Excel compared to Python libraries and be able to use Excel strategically within a Python-based workflow for data analysis.
5	Develop analytical expertise and problem-solving skills	Students will be able to approach data-driven challenges with a critical thinking mindset, solve problems using data analysis techniques, and collaborate effectively in a team setting.

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

Course Outcomes (COs)

COs	Description
M23BME408C.1	Utilize Python libraries (NumPy, Pandas, Matplotlib) to perform data manipulation, analysis, and visualization.
M23BME408C.2	Analyze and interpret statistical concepts using Python libraries.
M23BME408C.3	Implement and evaluate machine learning models (Linear Regression, Logistic Regression) using Python.

CO-PO-PSO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M23BME408C.1	-	-	-	-	-	-	3	-	-	-	-	-	3	-
M23BME408C.2	-	-	-	-	-	-	-	-	-	-	3	-	3	-
M23BME408C.3	-	-	-	-	-	-	-	-	3	-	-	-	3	-
M23BME408C	-	-	-	-	-	-	3	-	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

The field of data analytics is rapidly evolving, and the skills you're developing in this course will be highly sought-after in the years to come. Here's a glimpse into the exciting future that awaits you:

Rise of Big Data and Artificial Intelligence (AI): As the amount of data generated continues to explode, data analytics will become even more crucial for extracting insights and informing decision-making. You'll be well-positioned to work with advanced AI and machine learning algorithms that can automate tasks and uncover hidden patterns in massive datasets.

Domain Expertise with Data Skills: Combining your data analytics expertise with knowledge in a specific field like engineering, healthcare, or finance will be a powerful asset. You'll be able to translate complex data into actionable insights that drive innovation and solve real-world problems in your chosen domain.

Focus on Data Visualization and Storytelling: The ability to communicate complex data insights effectively will be paramount. Mastering data visualization tools and developing compelling data storytelling skills will allow you to engage a wider audience and ensure your findings have a significant impact.

Ethical Considerations and Data Privacy: As data becomes more pervasive, ethical considerations regarding data privacy and responsible use will become increasingly important. Your understanding of these issues will be valuable in ensuring data is collected, analyzed, and utilized ethically and responsibly.

Lifelong Learning and Adaptability: The data analytics landscape is constantly evolving with new tools, techniques, and technologies emerging. Your commitment to lifelong learning and continuous upskilling will be essential to stay ahead of the curve and thrive in this dynamic field.

4th Semester	Ability Enhancement Course (AE) UNIVERSAL HUMAN VALUES (UHV)	M23BUHK409

Universal Human Values (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		Total Marks	**100**
Credits	**01**	Exam Hours	**01 Hour**
Evaluation Method	SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions).		

Course objectives:

This course is intended to:

1. 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.
2. 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.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. 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.

1. 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.
2. 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.
3. State the need for UHV activities and their present relevance in society and provide real-life examples.
4. Support and guide the students in self-study activities.
5. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
6. 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.
7. 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: **(3 hours)**

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: **(3 hours)**

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: **(3 hours)**

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 in Existence

Module-5

Implications of the Holistic Understanding – a Look at Professional Ethics: (3 hours)

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 (Course Skill Set):

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, while keeping 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-day settings 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 behavior
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 Internal Evaluation) and SEE (Semester End Examination) taken together.

Final CIE for Theory based Ability Enhancement Course

	Components	Number	Weightage	Max. Marks	Min. Mar
	Internal Assessment-Tests (A)	2	50%	25	10
	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

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 P Bagaria, 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, R Asthana, 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 University Press
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy 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
16. 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 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.

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.

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 and economic 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 for implementation. 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 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:

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 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 /	Site selection / proper consultation/ Continuous monitoring/ Information board	Report should be submitted by an individual to the concerned evaluation	Evaluation as per the rubrics of the scheme and syllabus by NSS officer

			campus etc…		authority	
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
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	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

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	Sectorwise 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 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%**	• Implementation strategies of the

Presentation - 1 Selection of topic, PHASE - 1	**10 Marks**	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.
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**	
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.		

4th Semester	Non-Credit Mandatory Course (NCMC) YOGA	M23BYOK410

Yoga			
Course Code	**M23BYOK410**		
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 substance abuse (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
  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, 2 rounds
- 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
  e. Sitting
    1. Padmasana
    2. Vajrasana
  f. Standing
    1. Vrikshana
    2. Trikonasana
  g. Prone line
    1. Bhujangasana
    2. Shalabhasana
  h. Supine line
    3. Utthitadvipadasana
    4. 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.
- Different types of Asanas
  e. Sitting
    3. Sukhasana
    4. Paschimottanasana
  f. Standing
    3. Ardhakati Chakrasana
    4. Parshva Chakrasana
  g. Prone line
    2. Dhanurasana
  h. Supine line
    3. Halasana
    4. Karna Peedasana
- Meaning, importance and benefits of Kapalabhati.
- 40 strokes/min 3 rounds
- Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama.
- Pranayama
  6. Suryanuloma –Viloma
  7. Chandranuloma-Viloma
  8. Suryabhedana
  9. Chandra Bhedana
  10. Nadishodhana

Semester V

- Patanjali'sAshtanga Yoga its need and importance.
- Ashtanga Yoga
  1. Asana
  2. Pranayama
  3. Pratyahara
- Asana its meaning by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas
  a. Sitting 1. Ardha Ushtrasana 2. Vakrasana 3. Yogamudra in Padmasana
  b. Standing 1. UrdhvaHastothanasana 2. Hastapadasana 3. ParivrittaTrikonasana 4. Utkatasana
  c. Prone line 1. Padangushtha Dhanurasana 2. Poorna Bhujangasana / Rajakapotasana
  d. Supine line 1. Sarvangasana 2. Chakraasana 3. Navasana/Noukasana 4. Pavanamuktasana
- Revision of practice 60 strokes/min 3 rounds
- Meaning by name, technique, precautionary measures and benefits of each Pranayama 1. Ujjayi

2. Sheetali 3. Sheektari

Semester VI

- Ashtanga Yoga
  1. Dharana
  2. Dhyana (Meditation)
  3. Samadhi
- Asana by name, technique, precautionary measures and benefits of each asana
- Different types of Asanas
  a. Sitting 1. Bakasana 2. Hanumanasana 3. Ekapada Rajakapotasana 4. Yogamudra in Vajrasana
  b. Standing 1. Vatayanasana 2. Garudasana
  c. Balancing 1. Veerabhadrasana 2. Sheershasana
  d. Supine line 1. Sarvangasana 2. Setubandha Sarvangasana 3. Shavasanaa (Relaxation poisture).
- Revision of Kapalabhati practice 80 strokes/min - 3 rounds
- Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama 1. Bhastrika 2. Bhramari
- Meaning, Need, importance of Shatkriya.
- Different types. Meaning by name, technique, precautionary measures and benefits of each Kriya 1. Jalaneti & sutraneti 2. Nouli (only for men) 3. Sheetkarma Kapalabhati

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
6. https://youtu.be/KB-TYlgd1wE
7. https://youtu.be/aa-TG0Wg1Ls

4th Semester	Non-Credit Mandatory Course (NCMC) PHYSICAL EDUCATION (SPORTS & ATHLETICS) — I	M23BPEK410

Semester - III			
PHYSICAL EDUCATION (SPORTS & ATHLETICS) — I			
Course Code	**M23BPEK410**	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

Cos	Description
M23BPEK410.1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness.
M23BPEK410.2	Familiarization of health-related Exercises, Sports for overall growth and development.
M23BPEK410.3	Create a foundation for the professionals in Physical Education and Sports.
M23BPEK410.4	Participate in the competition at regional/state / national / international levels.
M23BPEK410.5	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.

Module-1

Orientation: **(5 hours)**

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

Module-2

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

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: **(10 hours)**

E. Postural deformities.
F. Stress management.
G. Aerobics.
H. 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**

Semester - IV
PHYSICAL EDUCATION (SPORTS & ATHLETICS) — II
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)** C. Ethics in Sports D. Moral Values in Sports and Games
Module-2
Specific Games (Any one to be selected by the student): **(20 hours)** A. Volleyball — Attack, Block, Service, Upper Hand Pass and Lower hand Pass. B. Throwball — Service, Receive, Spin attack, Net Drop & Jump throw. C. Kabaddi — Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. D. Kho-Kho — Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. E. Table Tennis — Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. F. 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	Basic Science Course (BSC) DIPLOMA MATHEMATICS-II	M23MATDIP411

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, 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 Coursework	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)**	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., Diploma 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:

1. **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-onpractice

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 mathematics 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)

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	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12
M23BDIPM411.1	3	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM411.2	3	-	-	-	-	-	-	-	-	-	-	-
M23BDIPM411.3	-	3	-	-	-	-	-	-	-	-	-	-
M23BDIPM411	3	3	-	-	-	-	-	-	-	-	-	-

9. Assessment Plan

Continuous Internal Evaluation (CIE)

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

Semester End Examination (SEE)

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

10. Future with this Subject

The "Diploma 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.

4th Semester	AICTE ACTIVITY POINT PROGRAM	

AICTE Activity Point Program
(Ref.: Chapter – 6 – AICTE Internship Policy – Guidelines & Procedures)

Ref. No.: VTU/BGM/ACA-OS/GEN-CIRS/2019-20/3014 dated 01/08/2019

Preamble:
Apart from technical knowledge and skills, students should have excellent soft skills, leadership qualities, and team spirit to be successful as professionals. They should have entrepreneurial capabilities and societal commitment. In order to match this multifarious requirement, AICTE has created a unique mechanism for awarding Activity Points over and above academic grades.

1. Every student admitted to the 4-year Degree program and entering the 4-year Degree program through lateral entry shall earn 100 and 75 Activity Points, respectively, for the degree award through the AICTE Activity Point Program. Students transferred from other Universities to the fifth semester must earn 50 Activity Points from the year of entry to VTU.
2. The Activity Points earned shall be reflected on the student's eighth-semester Grade Card.
3. The activities can be spread over the years (duration of the program), anytime during the semester, weekends, and holidays, as per the interest and convenience of the student from the year of entry to the program. However, the minimum hours specified must be satisfied.
4. Activity Points (non-credit) do not affect SGPA/CGPA and shall not be considered for vertical progression.
5. If a student fails to earn the prescribed Activity Points, the Eighth semester Grade Card shall be issued only after earning the required Activity Points. Students shall be admitted for the award of the degree only after the release of the Eighth semester Grade Card.
6. For more details, refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines.
7. Submission of Activity Points: The consolidated report of activity points earned by the students shall be sent to the Controller of Examinations. Dean-Academics will issue a notification in this respect.

Sl. No.	Student Category	Activity Points prescribed by AICTE
1.	Day College regular student admitted to the four-year Degree program (Admitted during 2022-23)	100
2.	A student entering the four-year Degree program through lateral entry (Admitted during 2022-23)	75
3.	Students transferred from other Universities to the fifth semester (Admitted during 2022-23)	50

AICTE Activity Point Programme (Activity Summary Sheet)

The AICTE Activity Program, a non-credit program, can be taken up at any time during the semester, on weekends, and on holidays. These activities can be spread over the years at the student's convenience. However, the minimum hours specified must be satisfied.

Students in teams of their choice may carry out the following suggestive activities.

Sl. No.	Activity Head	Minimum Duration		Performance Appraisal/ Maximum Point/ Activity	Evaluated by
		Weeks	Hours		
1.	Helping local schools to achieve good results and enhance their enrolment in Higher/Technical/ Vocational Education.	2	80-90	20	NSS/Youth Red Cross Coordinators /Chairperson-CICC (College Internal Complaints Committee) / SAGY (Sansad Adarsh Gram Yojana, GovL of India) of the
2.	Preparing an actionable business proposal to enhance the village's income.	2	80-90	20	
3.	Developing a Sustainable Water Management system	2	80-90	20	
4.	Tourism Promotion Innovative Approaches.	2	80-90	20	
5.	Promotion of Appropriate Technologies.	2	80-90	20	
6.	Reduction in Energy Consumption.	2	80-90	20	
7.	To Skill rural population.	2	80-90	20	
8.	Facilitating 100% Digitized money transactions.	2	80-90	20	

9.	The setting of the information-imparting club for women leads to contributions to social and economic issues.	2	80-90	20	institute/ Mentor
10.	Developing and managing an efficient garbage disposable system.	2	80-90	20	
11.	To assist in the marketing of rural produce.	2	80-90	20	
12.	Food preservation/packaging.	2	80-90	20	
13.	Automation of local activities.	2	80-90	20	
14.	Spreading public awareness under rural outreach program.	2	80-90	20	
15.	Contribution to any national-level initiative of the Government of India. E.g., Digital India/ Skill India/ Swachh Bharat Internship, etc.	2	80-90	20	
16.	Creating an awareness regarding rainwater harvesting in urban and rural areas.	2	80-90	20	