

Transforms and Statistics			
Course Code	1BMATM301	Scheme	2025
Type of Course	ASC	Semester	III
Teaching Hours/Week (L: T: P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:25:25	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03
Course outcome (Course Skill Set): At the end of the course, the student will be able to: CO1: Apply Fourier series techniques to represent periodic functions and perform harmonic analysis relevant to engineering applications. CO2: Utilize Fourier Transforms and Z-Transforms to analyze engineering systems and solve difference equations arising in mechanical and allied engineering problems. CO3: Formulate and solve partial differential equations and apply numerical methods for the solution of heat, wave, and Laplace equations encountered in engineering practice. CO4: Employ Laplace Transform techniques to solve ordinary differential equations and engineering problems involving dynamic systems. CO5: Analyze and interpret engineering data using statistical tools, measures of central tendency, dispersion, and data visualization techniques for informed decision-making.			
Module-1: Fourier Series			
Definition, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2π and arbitrary period, half range Fourier series. Complex form of Fourier Series. Practical harmonic analysis.			
Number of Hours: 8			
Module-2: Fourier Transform & Z-Transform			
Infinite Fourier transform, Fourier sine and cosine transforms, properties, Inverse Fourier transform, integral equations and related problems.			
Z-Transform: Definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems (statements only). Inverse Z- transforms, Problems on difference equations.			
Number of Hours: 9			
Module-3: Partial differential equations			
Partial Differential Equations: Definitions, Formation of PDE by eliminating arbitrary constants and arbitrary functions, Solution of non-homogeneous PDE by direct integration and Lagrange's multiplier method.			
Numerical solution of PDE: Classification of second order PDE. Finite difference approximation to derivatives, Numerical solution of One-dimensional Heat and Wave equations. Numerical solution of two-dimensional Laplace equation.			
Number of Hours: 9			
Module-4: Statistics-1			
Measures of central tendency: mean, median and mode for grouped and ungrouped data. Measures of dispersion: range, variance, standard deviation, quartile deviation, moments and coefficient of variation. Concept of Skewness and Kurtosis.			
Number of Hours: 8			
Module-5: Statistics-2			
Statistical Methods: Principles of least squares, Curve fitting by the method of least squares in the form: $y = a + bx$, $y = a + bx + cx^2$, and $y = ax^b$.			
Correlation and Regression: Karl Pearson's coefficient of correlation and rank correlation (with repetition and without repetition) -problems. Regression analysis- lines of regression –problems.			
Number of Hours: 8			
Suggested Learning Resources:			
Textbooks:			
1. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", 12 th Ed., S. Chand Publishing. 2. R K Jain and S R K Iyengar, "Advanced Engineering Mathematics", 5 th Ed., Narosa Publishing House. 3. B S Grewal, "Higher Engineering Mathematics", 45 th Ed., Khanna Publishers.			
Reference books / Manuals:			
1. B V Ramana, "Higher Engineering Mathematics", Mc Graw-Hill Education, 2017 2. M R Spiegel, J Schiller, and R A Srinivasan, "Schaum's Outline of Probability and Statistics", McGraw Hill. 3. S P Gupta, "Statistical Methods", 46 th Ed., Sultan Chand & Sons, 2023. 4. V K Rohatgi and A K Md. Ehsanes Saleh, "An Introduction to Probability and Statistics", 2 nd Ed., Wiley.			

Web links and e-Resources:

- <https://nptel.ac.in/courses/111105160>
- <https://nptel.ac.in/courses/127106019>
- <https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/>
- <https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/pages/syllabus/>

Teaching-Learning Process (Innovative Delivery Methods):

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self-study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to learn groups to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:
 - As an introduction to new topics (pre-lecture activity).
 - As a revision of topics (post-lecture activity).
 - As additional examples (post-lecture activity).
 - As an additional material of challenging topics (pre-and post-lecture activity).
 - As a model solution of some exercises (post-lecture activity).

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.

To qualify and become eligible to appear for SEE, in the CIE, a student must score at least **40% of 50 marks, i.e., 20 marks.**

To pass the SEE, a student must score at least **35% of 50 marks, i.e., 18 marks.**

Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE is at least 40 out of 100 marks.**

Continuous Comprehensive Assessments (CCA) + Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks.**

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks.**

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students.** These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 or RBL4 levels) for Teamwork	10
2.	GATE-based Aptitude Test	15

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

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

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar on Fourier Series of periodic functions and harmonic analysis	5
2.	MATLAB/Python Simulation of Fourier and Z-Transform problems	5
3.	Mini Project on statistical Models in Engineering Applications	10
4.	Case Study on Signal Processing using Transform Techniques	5
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1	MOOCs/NPTEL Courses	25

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):**1. Sample Rubrics - Mini-Project**

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition & data	Clear, relevant engineering questions; data source and limitations documented.	Mostly clear; minor gaps in context or data description.	Vague questions or poorly documented data.	10%
Data processing & descriptive statistics	Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.	Mostly correct; minor computational errors.	Significant errors, missing key measures or plots.	25%
Probabilistic modelling (distributions, inference)	Appropriate distributions and tests used; assumptions stated; results interpreted in context.	Reasonable choice of models; some assumptions implicit; interpretation mostly sound.	Inappropriate or poorly justified models; limited interpretation.	30%
Engineering insight / risk framing	Clear link to design/assessment decisions, safety and uncertainty; limitations discussed.	Some discussion of implications; limited treatment of limitations.	Minimal engineering interpretation on beyond numbers.	20%
Report & communication	Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation.	Acceptable structure; some clarity issues; presentation adequate.	Disorganized or incomplete report; weak presentation.	15%

Students' activities for TW/SL under NCrF: Samples only

As per National credit framework (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/SL-50 hours). Hence, students must complete minimum of two activities as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Manufacturing Processes			
Course Code	1BMR302	Scheme	2025
Type of course	IPCC	Semester	III
Teaching Hours/Week (L:T:P)	3:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:20:30	SEE Marks	50
Credits	4	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3
Course Outcome (Course Skill Set): At the end of the course, the student will be able to: 1. Explain the concepts of metal casting, forming, welding and metal cutting. 2. Assess, compare and select appropriate manufacturing Processes. 3. Apply principles of casting, forming, welding, and metal cutting to specific applications. 4. Adapt the principles of manufacturing processes to develop the mechanical components.			
Module-1			
Casting Process: Sand casting: pattern and core making- materials, allowances, types, moulding process - sand properties, melting furnaces – pit furnace and electric furnaces. Melting and founding of cast iron, degasification, design of casting and risering, pouring and feeding of casting. Special casting processes: Shell, investment, die casting – pressure and gravity types – squeeze casting - defects in casting. Plastic moulding – injection and blow moulding. Number of Hours: 9			
Module-2			
Welding Processes: Definition, Principles, classification, application, advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW). Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding. Gas welding: Principle, oxy-Acetylene welding, oxyhydrogen welding, air-acetylene welding, Gas cutting, Defects and Inspection of welded joints. Number of Hours: 8			
Module-3			
Machining processes: Lathe: Review of- working principle, classification, specification, different operations on a lathe. Lathe accessories and tool holders, machining time and power required for cutting. Capstan lathe and Turret lathe, Introduction to CNC lathe, parts and functions. Drilling and boring - classification, specification and constructional features of drilling and boring machines, machining time calculation Milling - classification, principle, parts & specification of milling machines, milling process-cutters, indexing Shaping, Planing and Slotting machines- constructional features and machining operations Number of Hours: 8			
Module-4			
Metal forming processes: Hot and cold working processes – Rolling, forging, drawing and extrusion processes, bending, hot spinning, shearing, tube and wire drawing, cold forming, shot peening. Sheet metal working – Blanking, Piercing, Punching, Trimming, Bending – types of dies – progressive, compound and combination dies. High-energy rate forming processes. Additive Manufacturing: Introduction to 3D-printing and rapid prototyping Number of Hours: 8			
Module-5			
Advanced Machining Processes: Abrasive Jet Machining, Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, Electrochemical Machining, Laser Beam Machining, Plasma Arc Machining, Electron Beam Machining. Number of Hours: 9			
Finishing Process: Surface finishing processes: Grinding, Lapping, honing and super finishing process – overview of machines used, grinding wheels and specification, selection of grinding wheels, ship hull finishing. Number of Hours: 9			

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Study the effect of clay and moisture content on sand mould properties
2. Preparation of sand specimens and conduction of Compression, Shear, and Tensile tests using Universal Sand Testing Machine
3. Determine the permeability number of green sand, core sand, and raw sand
4. Determine AFS fineness number and distribution coefficient of the given sand sample
5. Demonstration: Operation on any one advanced machining process
6. Demonstration: Experimentation of simple programming of CNC machine operations
7. Design and develop a model of ship components using sand moulding and aluminium casting
8. Fabricate a ship component model using arc welding (L-Joint, T-Joint, Butt joint, V-Joint, Lap joint)
9. Develop a ship component using forging operations (upsetting, drawing, bending)
10. Manufacture ship components using Lathe, Shaping, Milling, Drilling, and Grinding processes
11. Design and demonstrate the use of Drill Jig & turning/grinding fixtures for a chosen component
12. Develop and execute a customized CNC program for machining a selected ship component

Suggested Learning Resources:

Textbooks:

1. P N Rao, "Manufacturing Technology", Vol. 1 – Foundry, Forming, and Welding, 5th Ed., McGraw Hill Education (India) Private Limited, 2018.
2. P N Rao, "Manufacturing Technology", Vol. 2 - Metal Cutting and Machine Tools, 4th Ed. McGraw Hill Education (India) Pvt. Limited, 2018.
3. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., "Elements of Workshop Technology", Vol. I, 10th Ed., Media Promoters & Publishers, 2007.
4. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., "Elements of Manufacturing Technology" Vol. II, 15th Ed., Media Promoters & Publishers, 2010.

Reference Books / Manuals:

1. H.M.T., "Production Technology", Tata McGraw-Hill, 2000.
2. Serope Kalpakjian, Steven, R Schmid, "Manufacturing Engineering and Technology," 4th Ed., Pearson, 2011.
3. Roy A Lindberg, "Process and Materials of Manufacturing", 4th Ed., Pearson, 2006.
4. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley Publications, 2019.

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/112107219>
2. <https://nptel.ac.in/courses/112104301>
3. <https://nptel.ac.in/courses/112104028>
4. <https://nptel.ac.in/courses/112103248>
5. <https://nptel.ac.in/courses/112105127>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Simulation and Virtual Labs
- ICT-Enabled Teaching

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each). The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

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

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

CIE Practical component:

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

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

Continuous Internal Evaluation (CIE)**(i) Theory component**

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

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

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

(ii) Laboratory component

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

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

(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Table – ICs/IPCCs 1 Distribution of marks		
Component	Description	Marks
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
Subtotal		15
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
Subtotal		10
Total		25

Rubrics for Practical CIE – Continuous Assessment:

Performance Indicator (COs/POs)	Superior	Good	Fair	Needs Improvement	Unacceptable
Ability in Conducting Experiments (CO3/PO2, PO3, PO4, PO8) (10 Marks)	Demonstrates excellent understanding of the experiment, independently prepares specimens, safely operates equipment, follows procedures accurately, records observations systematically, actively participates in the experiment and analyse the results effectively (9 – 10 Marks)	Performs the experiment correctly with minimal guidance, follows safety practices, and records observations with only minor errors. (7 - 8 Marks)	Performs the experiment satisfactorily with occasional guidance, follows procedures adequately, and records acceptable observations (5 - 6 Marks)	Requires frequent assistance in conducting the experiment, shows limited understanding of equipment/procedure, and records incomplete or inaccurate observations. (3 – 4 Marks)	Unable to perform the experiment independently, does not follow procedures or safety practices, and fails to obtain or record meaningful observations. (1 - 2 Marks)
Laboratory Record / Journal (PO9) (20 Marks)	Record book is complete, neat, and well-organized with objectives, theory, procedure, observations, calculations, graphs/microstructures, results, discussion, and precautions.	Record book is complete with good presentation; minor omissions or formatting errors; calculations and results are mostly accurate;	Record book contains all essential sections but lacks detail in presentation, analysis, or interpretation; few calculation or recording errors.	Record book is incomplete, poorly organized, contains several errors or missing sections, and/or delayed submission. (5 - 8 Marks)	Record book is largely incomplete, inaccurate, poorly maintained, or not submitted. (2 - 4 Marks)

	Results are accurate and submitted on time. (17 – 20 Marks)	submitted on time. (13 – 16 Marks)	(9 - 12 Marks)		
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Term Work (TW) and Self Learning (SL) components in Number of hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Study an existing engineering component and identify the sequence of manufacturing processes used for its production with justification - Case Study Presentation	10
2.	Explore casting simulation, welding simulation, or forming simulation software and prepare a technical report.	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	MOOCs/NPTEL Courses/Video Lectures	30

Engineering Thermodynamics			
Course Code	1BAU303	Scheme	2025
Type of Course	PCC	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L:T:P:SL:TW	42:0:0:38:10	SEE Marks	50
Credits	03	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03
Course Outcome (Course Skill Set): At the end of the course, the student will be able to: 1. Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems. 2. Evaluate the feasibility of cyclic and non-cyclic processes using second law of thermodynamics 3. Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and apply first law of thermodynamics to closed and open systems and determine quantity of energy transfers and change in properties. 4. Apply thermodynamic concepts to analyse the performance of gas and vapour power cycles. 5. Explain the principles, applications of refrigeration and air conditioning systems			
Module-1			
Thermodynamic System and Control Volume, Surroundings. Macroscopic and Microscopic Analysis. Definition of Substance, Properties of Substance, Intensive and Extensive Property, thermodynamic State, Thermodynamic Equilibrium, Concept of Quasi Equilibrium Process and Cycle. Fundamental Units, Units of Force, Energy, Specific Volume, Pressure etc. Equality of Temperature, The Zeroth Law of Thermodynamics, Temperature Scales. Numericals Number of Hours: 9			
Module-2			
Heat and Work: Definition of Thermodynamic Work, Forms of Work. Definition of Heat, Inter Convertibility of Heat/work into Work/heat, Governing Principles, Sign Convention. Numericals First Law of Thermodynamics: First Law for Cyclic Process, First Law for Change of State of a System. Internal Energy, A New Thermodynamic Property. Enthalpy, The Constant Volume and Constant Pressure. Numericals Number of Hours: 9			
Module-3			
Second Law of Thermodynamics: Definition of Heat Engine, heat pump and Reservoirs, Kelvin-Planck and Clausius Statements of the Second Law, Reversible and Irreversible Engines and processes, Causes of Irreversibility, Numericals Carnot Cycle: Efficiency of a Carnot Cycle, Thermodynamic Temperature Scale, Ideal Gas Temperature Scale. Entropy: Clausius Inequality, Entropy - A Property of a System, Entropy of a Pure Substance, Entropy Change in Reversible Process, Thermodynamic Property Relation, Calculation of Change in Entropy, Principle of Increase of Entropy. Numericals Number of Hours: 8			
Module-4			
Analysis of Power Generation Cycles: Air-standard Power Cycles - Concept, Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle. Efficiency and Mean Effective Pressure. Numericals Number of Hours: 8			

Module-5											
Analysis of Refrigeration Cycles: Air-standard Cycles - Joule Cycle. Introduction to Refrigeration Systems, Vapor compression Refrigeration Cycle, Vapor-absorption Refrigeration Cycle. Numericals Psychometrics and Air-conditioning Systems: Psychometric properties of Air, Psychometric Chart, Analysing Air conditioning Processes; Heating, Cooling, Dehumidification and Humidification. Numericals Number of Hours: 8											
Suggested Learning Resources:											
Textbooks: 1. P K Nag, "Basic and Applied Thermodynamics", 2nd Ed., McGraw Hill Education, 2009. 2. Dr D S Kumar, "Engineering Thermodynamics", S. K. Kataria & Sons, 2012. 3. B K Venkanna and Swati B. V, "Basic Thermodynamics", PHI, New Delhi, 2010.											
Reference books / Manuals: 1. Yunus A. Cengel, Michael A. Boles, Mehmet Kanoglu, "Thermodynamics- An Engineering Approach", 10th Ed., McGraw Hill Education, 2019. 2. V Ganesan, "Thermodynamics: Basic and Applied", McGraw Hill Education (India), 2018.											
Web links and Video Lectures (e-Resources): 1. https://nptel.ac.in/courses/127106135 2. https://nptel.ac.in/courses/112106320 3. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8											
Teaching-Learning Process (Innovative Delivery Methods): The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes. ➤ Video demonstrations ➤ Simulations. ➤ Flipped Classroom ➤ Problem-Based Learning (PBL) ➤ Group Learning											
Assessment Structure: The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage. • To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks. • To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks. • Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks.											
Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks] A minimum of two Internal Assessment Tests (IA) shall be conducted, carrying a total of 25 marks . In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks . It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students . These activities shall be:											
	<table border="1"> <thead> <tr> <th>Sl. No.</th><th>Name of the Learning activity</th><th>Maximum Marks</th></tr> </thead> <tbody> <tr> <td>1.</td><td>Case Study Presentation on Thermodynamic Systems and Energy Interactions</td><td>15</td></tr> <tr> <td>2.</td><td>Psychometric chart and Problem-Solving: Activity</td><td>10</td></tr> </tbody> </table>	Sl. No.	Name of the Learning activity	Maximum Marks	1.	Case Study Presentation on Thermodynamic Systems and Energy Interactions	15	2.	Psychometric chart and Problem-Solving: Activity	10	
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1.	Case Study Presentation on Thermodynamic Systems and Energy Interactions	15									
2.	Psychometric chart and Problem-Solving: Activity	10									

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1 Case Study Presentation on Thermodynamic Systems and Energy Interactions					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Identification and Classification of Thermodynamic System (CO1/PO1)	Correctly identifies and classifies the thermodynamic system with complete justification, including boundaries, surroundings, and system type.	Correctly identifies and classifies the system with minor omissions.	Classification is mostly correct but lacks adequate justification.	Classification contains significant errors and misconceptions.	Unable to identify or classify the thermodynamic system.
Analysis of Energy Interactions (CO1, CO2/PO2)	Accurately identifies all heat and work interactions and explains them using thermodynamic principles.	Identifies most energy interactions with minor errors in explanation.	Demonstrates basic understanding of energy interactions.	Limited understanding with several errors in analysis.	Unable to identify or explain energy interactions.
Application of Thermodynamic Concepts and Laws (CO2, CO3/PO2)	Applies thermodynamic laws and concepts correctly with logical reasoning and supporting analysis.	Applies concepts correctly with minor errors.	Partial application of thermodynamic concepts with limited analysis.	Inadequate application of thermodynamic principles.	No meaningful application of thermodynamic concepts.
Technical Report Preparation (CO1/PO10)	Comprehensive and professional report	Good report	Average report	Poor report	No report
Presentation and Team Participation (PO9, PO10)	Highly active and collaborative	Good participation	Moderate participation	Limited participation	No participation

Rubrics for Learning Activity 2: Psychometric chart and Problem-Solving Activity					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Identification of States and Properties (CO5, PO1)	Correctly identifies all steam states and accurately determines relevant properties from charts.	Correctly identifies most states with minor errors in property evaluation.	Identifies basic states with moderate accuracy.	Significant errors in identifying states and properties.	Unable to identify states or determine properties.
Use of Chart (CO5, PO1, PO2)	Uses chart accurately and efficiently to obtain required thermodynamic properties.	Uses charts correctly with minor calculation or reading errors.	Demonstrates basic ability to use charts.	Limited ability to extract accurate information.	Unable to use chart effectively.
Problem Solving and Analysis (CO5, PO2)	Applies principles correctly and obtains accurate solutions with clear methodology.	Mostly correct analysis	Partial analysis	Minimal analysis	No analysis
Interpretation of Results and Engineering Significance (CO5, PO2)	Provides excellent interpretation of results and relates findings to engineering applications.	Good interpretation with minor gaps.	Basic interpretation of obtained results.	Poor interpretation of obtained results.	No interpretation
Technical Report Preparation (CO5, PO10)	Comprehensive and professional report	Good report	Average report	Poor report	No report

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Case Study	23
2.	Psychometric chart and Problem-Solving Activity	15
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Video Lectures	10

Mechanics of Materials			
Course Code	1BME304	Scheme	2025
Type of Course	PCC	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L:T:P:SL:TW	42:0:0:38:10	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3
Course Outcome (Course Skill Set): At the end of the course, the student will be able to: 1. Understand and analyse equilibrium of particles and rigid bodies 2. Determine stresses and strains in axially loaded members 3. Analyze torsional behavior of circular shafts 4. Analyze stresses and deformations in beams 5. Evaluate complex stress systems and pressure vessels			
Module-1			
Equilibrium of a Particle - Condition for the Equilibrium of a Particle, The Free-Body Diagram, Coplanar Force Systems. (Numericals) Force System Resultants - Moment of a Force—Scalar Formulation, Principle of Moments, Moment of a Couple, Reduction of a Simple Distributed Loading. (Numericals) Equilibrium of a Rigid Body -Conditions for Rigid-Body Equilibrium, Free-Body Diagrams, Equations of Equilibrium, Two- and Three-Force Members, Constraints and Statical Determinacy. (Numericals) Number of Hours: 9			
Module-2			
Introduction: Normal Stress and Strain; Mechanical Properties of Materials; Elasticity, Plasticity, and Creep; Hooke's Law, and Poisson's Ratio; Shear Stress and Strain; Allowable Stresses and Allowable Loads (Numericals) Axially Loaded Members: Changes in Lengths of Axially Loaded Members; Thermal Effects, Stresses on Inclined Sections; Strain Energy; Stress Concentration (Numericals). Number of Hours: 8			
Module-3			
Torsion: Introduction; Torsional Deformations of a Circular Bar; Circular Bars of Linearly Elastic Materials; Stresses and Strains in Pure Shear; Relationship Between Moduli of Elasticity E and G; Transmission of Power by Circular Shafts; (Numericals). Number of Hours: 8			
Module-4			
Stresses in Beams: Pure Bending and Nonuniform Bending; Curvature of a Beam; Longitudinal Strains in Beams; Normal Stresses in Beams; Design of Beams for Bending Stresses; Shear Stresses in Beams of Rectangular Cross Section; Shear Stresses in Beams of Circular Cross Section; Shear Stresses in the Webs of Beams with Flanges. (Numericals). Shear Forces and Bending Moments: Introduction; Types of Beams, Loads, and Reactions; Shear Forces and Bending Moments; Relationships Among Loads, Shear Forces, and Bending Moments; Shear-Force and Bending-Moment Diagrams; (Numericals). Number of Hours: 9			
Module-5			
Analysis of Stress and Strain: Introduction; Plane Stress; Principal Stresses and Maximum Shear Stresses; Mohr's Circle for Plane Stress; Hooke's Law for Plane Stress; Plane Strain; (Numericals). Pressure Vessels, Beams, and Combined Loadings: Spherical Pressure Vessels; Cylindrical Pressure Vessels; Combined Loadings (Axial + Bending and Axial + Torsion only) (Numericals). Number of Hours: 8			

Suggested Learning Resources:**Textbooks:**

1. Hibbeler R C, "Engineering Mechanics: Statics", 14th Ed., Pearson. ISBN: 978-0133918922, 2016
2. Goodno B J & Gere J M, "Mechanics of Materials", Enhanced Edition, 9th SI Ed., Cengage Learning. ISBN: 978-0357377857, 2020.

Reference books / Manuals:

1. Ferdinand P Beer, E. Russell Johnston, David Mazurek, Phillip J Cornwell and Brian Self, "Vector Mechanics for Engineers: Statics and Dynamics, 12th Ed., McGraw Hill, 2024.
2. Hibbeler R C, "Mechanics of Materials", 11th Ed., Pearson Education, 2024.
3. Meriam J L and Kraige L G, "Engineering Mechanics: Statics", 9th Ed., John Wiley & Sons, 2020.
4. Ferdinand P Beer, E Russell Johnston, John T DeWolf, David F Mazurek and Sanjeev Sanghi, "Mechanics of Materials", 8th Ed., McGraw Hill Education, 2020.
5. James M Gere and Barry J Goodno, "Mechanics of Materials", 9th Ed., Cengage Learning, 2018.
6. Timoshenko S P and Young D H, "Elements of Strength of Materials", 5th Ed., McGraw Hill Education, 2017 (Reprint).
7. Arthur P Boresi and Richard J Schmidt, "Advanced Mechanics of Materials", 6th Ed., John Wiley & Sons, 2003.

Web links and Video Lectures (e-Resources):**Web Resources:**

1. MIT OpenCourseWare – Solid Mechanics (Statics and Strength of Materials):
<https://ocw.mit.edu/courses/1-050-solid-mechanics-fall-2004/>
2. MIT OpenCourseWare – Mechanics & Materials I:
<https://ocw.mit.edu/courses/2-001-mechanics-materials-i-fall-2006/>
3. Virtual Labs (IITs) – Strength of Materials Laboratory:
<https://eerc01-iiith.vlabs.ac.in/>

Video Lecture Resources:

1. NPTEL – Engineering Mechanics (IIT lectures)
<https://nptel.ac.in/courses/112106286>
2. Jeff Hanson – Statics Lecture Series
<https://www.youtube.com/playlist?list=PLRqDfxcafc23LXGoItpkYMKtUdHaQwSDC>
3. MIT OpenCourseWare – Mechanics of Materials
<https://ocw.mit.edu/courses/3-11-mechanics-of-materials-fall-1999/>
4. Jeff Hanson – Mechanics of Materials Playlist
<https://www.youtube.com/playlist?list=PLRqDfxcafc21wll3E56IkDmRJ-33apMjv>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Problem-Based Learning (PBL)
- Simulation and Virtual Labs
- ICT-Enabled Teaching

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

- i) A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.
- ii) In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	To analyse and solve engineering problems involving any three or more of the following topics: equilibrium of particles and rigid bodies, stress analysis, axially loaded members, torsion, bending and shear in beams, pressure vessels, and combined loading, and interpret the results from an engineering perspective.. – Technical Report	15
2.	Structural Analysis of Engineering Components - Case Study Presentation	10

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1:

To analyse and solve engineering problems involving any three or more of the following topics: equilibrium of particles and rigid bodies, stress analysis, axially loaded members, torsion, bending and shear in beams, pressure vessels, and combined loading, with appropriate engineering interpretation of the results. – Technical Report

Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Formulation (PO1, PO2)	Correctly identifies engineering problem, assumptions and develops appropriate Free Body Diagrams/models.	Minor omissions in assumptions or modelling.	Adequate understanding with limited justification.	Incorrect assumptions or incomplete formulation.	Unable to formulate the problem.
Analytical Solution (PO1, PO2, PO3)	Accurate calculations with correct application of engineering principles and equations.	Minor computational errors.	Correct approach with moderate calculation errors.	Frequent conceptual and computational errors.	Unable to solve the problem.
Engineering Interpretation (PO2, PO4)	Critically analyses results, validates assumptions and provides meaningful engineering conclusions.	Good interpretation with minor omissions.	Basic interpretation of results.	Limited interpretation and discussion.	No meaningful interpretation.

Technical Documentation (PO9)	Well-organized, neat, complete and professionally documented.	Good documentation with minor deficiencies.	Acceptable documentation.	Poor organization and incomplete documentation.	Inadequate submission.
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Rubrics for Learning Activity 2:					
Structural Analysis of Engineering Components - Case Study Presentation					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Identification (P01, P02)	Clearly identifies the engineering problem with complete justification.	Correctly identifies the problem with minor omissions in assumptions.	Identifies the problem with minor errors	Incomplete or incorrect problem formulation	Unable to identify or formulate the engineering problem.
Application of Mechanics Principles (P01, P02, P03)	Correctly applies three or more mechanics concepts (equilibrium, stress analysis, torsion, bending, pressure vessels, combined loading, etc.) and sound engineering reasoning.	Applies the relevant concepts with minor conceptual errors.	Applies basic concepts with moderate errors.	Limited application of mechanics principles; frequent errors.	Unable to apply the relevant mechanics concepts.
Analysis, Interpretation and Design Recommendations (P02, P04)	Critically analyses results, validates assumptions, identifies failure/safety concerns, and proposes feasible engineering recommendations with justification.	Provides appropriate analysis and recommendations with minor omissions.	Performs basic analysis and provides limited recommendations.	Interpretation is incomplete or lacks engineering justification.	No meaningful analysis or recommendations.
Presentation and Technical Communication (P09)	Presentation is well-organized, technically sound, visually effective, and delivered confidently with accurate responses to questions.	Good organization and communication with minor deficiencies.	Adequate presentation and communication.	Poor organization or ineffective communication.	Unable to communicate technical content effectively.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Technical Report	23
2.	Case Study	15
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	MOOCs/NPTEL Courses	10

Material Science and Measurement Systems			
Course Code	1BMR305	Scheme	2025
Type of Course	PCC	Semester	III
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L:T:P:SL:TW	42:0:0:28:20	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3
Course Outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Explain behaviour of various materials with respect to crystal structure, mechanical behaviour, phase transformation and corrosion. 2. Identify suitable materials for specific engineering application 3. Explain the objectives of measurement, methods of measurement, standards of measurement & various measurement parameters. 4. Analyze measurement systems, transducers and describe functioning of force, torque, pressure, strain measuring devices			
Module-1			
Crystal Structure and Failure of Materials: Crystal Structure: Crystal Lattice, Unit Cell, space lattice and Atomic packing factor of BCC and FCC, simple numerical. Imperfections in Solids: Types of imperfections, Point defects, line defects, and 3D-defects. Failure of Materials: Fracture – Definition of fracture, ductile & brittle fracture, fracture mechanism Fatigue: Definition of fatigue, Types of fatigue loading with examples, Mechanism of fatigue. Creep: Definition of creep, mechanism of creep, creep curve, factors affecting creep. Number of Hours: 9			
Module-2			
Solidification and Ferrous and Non-ferrous Materials: Solidification: Mechanism of solidification, Homogeneous and Heterogeneous nucleation, Crystal growth, cast metal structures, Solidification of Steels and Cast irons. Gibbs phase rule, Iron-Carbon (Cementite) diagram: description of phases, Effect of common alloying elements in steel. Ferrous and non-ferrous materials: Properties, Composition and uses of Grey cast iron, malleable iron, SG iron, Copper alloy and Aluminium alloys. Number of Hours: 8			
Module-3			
Heat Treatment and Surface Hardening Methods: Heat Treatment: Time-Temperature Transformation (TTT) curve, Heat treatment: Annealing- Types of annealing, Normalizing, Hardening, Tempering, Concept of hardenability, Factors affecting hardenability. Surface hardening methods: Carburizing, Cyaniding, Nitriding, Flame hardening and Induction hardening Number of Hours: 8			
Module-4			
Measurement System and Basic Concepts of Measurement Methods: Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers. Number of Hours: 8			
Module-5			
Applied Mechanical Measurement: Linear measurement and angular measurements: Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Measurement of angle-sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.			

Applied mechanical measurement: Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Number of Hours: 9

Suggested Learning Resources:

Textbooks:

1. Beckwith Marangoni and Lienhard, "Mechanical Measurements", 6th Ed., Pearson Education, 2006.
2. R K Jain, "Engineering Metrology", Khanna Publishers, 2009.
3. William D Callister, "Material Science and Engineering", 6th Ed., John Wiley and Sons, 1997.
4. Raghavan V, "Materials Science and Engineering: A First Course", 6th Ed., PHI Learning, 2015.

Reference books / Manuals:

1. Richard S Figliola and Donald E Beasley, "Theory and Design for Mechanical Measurements", 3rd Ed., WILEY India Publishers, 2015.
2. O P Khanna, "A text book of Material Science and Metallurgy", Dhanpat Rai Publishers, 2010.
3. Avner S H, "Introduction to Physical Metallurgy", 2nd Ed., McGraw Hill Education, 2017.

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/113102080>
2. <https://nptel.ac.in/courses/112106293>
3. <https://nptel.ac.in/courses/112104122>
4. <https://nptel.ac.in/courses/112106139>
5. <https://nptel.ac.in/courses/112104250>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Simulation and Virtual Labs
- ICT-Enabled Teaching

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks, i.e., 20 marks.**
- To pass the **SEE**, a student must score at least **35% of 50 marks, i.e., 18 marks.**
- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks.**

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

- i) A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.
 ii) In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include a **maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Case Study on Material Failure & Selection	10
2.	Measurement System Demonstration / Mini Project	15

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1: Case Study on Material Failure & Selection					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Understanding of Case (5 Marks) (PO 1)	Demonstrates deep understanding (5 Marks)	Good understanding (4 Marks)	Adequate understanding (3 Marks)	Limited understanding (2 Marks)	No clear understanding (0-1 Mark)
Analysis & Critical Thinking (5 Marks) (PO 2)	Thorough, logical analysis with strong reasoning and innovative insights. (5)	Clear analysis with mostly logical reasoning. (4)	Basic analysis with some reasoning gaps. (3)	Weak analysis; mostly descriptive without reasoning. (2)	No clear analysis or reasoning. (0-1)
Presentation Skills & Organization (10 Marks) (PO 10)	Well-structured, clear, confident delivery; excellent visuals. (9-10)	Good structure, clear delivery; visuals mostly effective. (7-8)	Average structure; delivery clear but lacks engagement. (5-6)	Poor organization; visuals unclear. (3-4)	Unclear, disorganized presentation. (0-2)
Q&A Handling (5 Marks) (PO 10)	Confident, accurate, and concise responses.	Good responses	Adequate responses;	Weak or hesitant responses.	Unable to answer questions.

	(5)	with minor gaps. (4)	some uncertainty. (3)	(2)	(0-1)
Documentation (5 Marks) (PO 10)	Documentation is complete, accurate, well-structured, follows all formatting guidelines. (5)	Documentation is mostly complete and accurate, well-organized, follows formatting guidelines with minor deviations. (4)	Documentation covers most required elements but has some inaccuracies or omissions. (3)	Documentation is incomplete with noticeable inaccuracies. (2)	Documentation is largely missing or irrelevant, lacks structure. (0-1)

Rubrics for Learning Activity 2: Measurement System Demonstration / Mini Project					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Measurement System Design & Suitability (10 Marks) (PO 1)	Appropriate measurement system selected (e.g., force, pressure, torque, strain, slip gauges, transducers) exactly matching the application; strong justification with real-world/industrial relevance. (9-10)	Mostly correct system selection with good justification. (7-8)	Partially correct selection; justification incomplete or lacks clarity. (5-6)	Incorrect selection for fire type; weak reasoning. (3-4)	Completely inappropriate system; no justification. (0-2)
Technical Knowledge & Working Principle (5 Marks) (PO 2)	Clear and accurate explanation of working principle, components, transducers, and measurement process; includes advantages, limitations, and applications. (5)	Mostly accurate explanation with minor errors. (4)	Basic understanding ; some important concepts missing. (3)	Several errors; weak conceptual clarity. (2)	Incorrect or very limited technical knowledge. (0-1)
Error Analysis & Measurement Characteristics (5 Marks) (PO 2 / PO 1)	Clearly explains measurement errors (systematic, random), static & dynamic characteristics (accuracy, precision, sensitivity, etc.) with proper application to the system. (5)	Good explanation with minor gaps. (4)	Basic understanding ; limited discussion of errors/characteristics. (3)	Poor linkage between theory and system performance. (2)	No application to shipboard scenarios. (0-1)

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Case Study on Material Failure & Selection	12
2.	Measurement System Demonstration / Mini Project	16
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
2.	MOOCs/NPTEL Courses	20

Computer Aided Machine Drawing Lab		Scheme	2025
Course Code	1BMEL306	Semester	III
Teaching Hours/Week (L:T:P)	0:0:4	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:56:4:0	SEE Marks	50
Credits	2	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	2
Course Outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Apply 2D sketching and parametric constraints using CAD software. 2. Develop 3D models of machine components using feature-based modeling. 3. Create assembly models with proper constraints and interference checks. 4. Generate detailed & drafted production drawings with GD&T, BOM and standards.			
Module 1- Engineering Graphics Standards and CAD Sketching			
• Introduction to BIS Specification for line conventions, dimension, tolerance representation, basic terminology of GD&T, feature control frame, tolerance characteristic and symbols, modifiers and surface texture symbols • Thread Forms: Thread terminology, Thread conventions, ISO Metric (Internal & External), BSW (Internal & External), Acme and Sellers Thread. Representation of Hexagonal headed bolt and nut assembly with washer. • Orthographic Views: Conversion of pictorial views into orthographic views of simple machine parts with and without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Precedence of lines, Basics of geometric dimension. (Component drawing to be done in CAD software) • Overview of CAD software interface, environment of 2D Sketching: Sketch tools: line, circle, arc, spline Constraints: geometric & dimensional Editing tools and construction geometry			
			Number of Hours: 14
Module 2- Parametric Part Modelling			
• Introduction to parametric modeling • Basic part modeling: Extrude, Revolve, Cut, Sweep • Dimensioning standards (ISO) • Practice Exercises: Simple machine components (washer, bracket, flange) • Advanced features: Fillet, Chamfer, Shell, Draft • Patterning: Linear, circular, mirror • Hole features: Threaded holes, standard hole tables • Rib and thin features • Editing and modification tools • Practice Exercises: Knuckle joint components, Connecting rod, Spanner, Cranking Handle, Bearing bracket (part modeling)			
			Number of Hours: 14
Module 3- Assembly Modelling and Engineering Documentation			
• Drafting environment • Orthographic projections & sectional views • Dimensioning and annotations • Geometric Dimensioning & Tolerancing (GD&T) • Limits, fits and tolerances • Bill of Materials (BOM) • Title block and standards • Exporting drawings (PDF, DWG) • Assembly environment in CAD software • Bottom-up and top-down assembly • Assembly constraints: Mate, align, insert, angle • Exploded views • Interference detection			

- Keys and Coupling: Assembly of muff coupling with taper sunk key & protected flange coupling with sunk key.
- Assembly Drawing Exercises:
 - Plummer block
 - Screw Jack
 - Machine Vice
 - Engine Piston
 - Tailstock of Lathe
 - I.C. Engine Connecting Rod

Number of Hours: 28

Suggested Learning Resources:**Textbooks:**

1. N D Bhat & V M Panchal, "Machine Drawing", Charotar Publishing House, 1999.
2. K R Gopala Krishna, "Machine Drawing", Subhash Publications.
3. "A Primer on Computer Aided Machine Drawing – 2007", Published by VTU, Belagavi.

Reference books / Manuals:

1. S Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", 2nd Ed., CBS Publishers, New Delhi, 2007.
2. N Siddeshwar, P Kannaih and V V S Sastry, Machine Drawing, Tata McGraw-Hill, 2006.
3. K L Narayana, P Kannaiah and K Venkata Reddy, "Machine Drawing", 6th Ed., New Age International, 2006.
4. Solid Edge ST/2023/2024 User Manual, Siemens Digital Industries Software (Official Documentation).
5. Solid Edge Tutorials & Training Guides, Siemens Learning Resources.

Web links and Video Lectures (e-Resources):

1. <https://www.youtube.com/@NxTutor>
2. https://www.youtube.com/watch?v=vXpbeN6ryWM&list=PLpfdJLK2qQLbua_nqAVrg33-vclj76Vr2
3. https://www.youtube.com/watch?v=Q1T4d4TBGn0&list=PLpfdJLK2qQLbua_nqAVrg33-vclj76Vr2&index=5
4. <https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional>

Teaching-Learning Process (Innovative Delivery Methods):

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

- ICT-Enabled Teaching
- Adopt collaborative (Group Learning) learning in the class.
- Demonstrations

Assessment Structure:

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

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course is 50 Marks.
- CIE shall be evaluated for 50 marks as detailed below:
The final CIE (50) = Class work marks (30) + Test marks (20)
- CIE component should comprise of
 - Continuous evaluation of Drawing work of students as and when the Modules are covered based on the weightage as shown in the following table.

Module	Max. Marks weightage	Evaluation Weightage in marks	
		Computer display & printout (a)	Preparatory sketching (b)
Module-1	20	10	10
Module-2	20	20	0
Module-3	60	60	0
Total	100	90	10
Consideration of Class work		Total of [(a) + (b)] = 100 Scaled down to 30 Marks	

- At least one Test covering all the modules is to be conducted for 100 marks and evaluation to be based as per SEE pattern, and the obtained marks is to be scaled down to 20 Marks.

Semester End Examination (SEE):

- SEE shall be conducted in batches similar to practical's and evaluated for maximum of 100 Marks. Obtained marks shall be accounted for SEE final marks, reducing it by 50%.
- Two full questions shall be set from Modules 1, 2 and 3. Students need to answer one full question from each module.
- Two full questions set from each Module shall cover the entire topic of the respective module.
- Question papers shall be provided by the University for each batch as per schedule.
- SEE shall be conducted by one Internal and one External Examiner.
- Evaluation shall be carried out jointly by both the examiners.
- The student may be awarded full marks, if he/she completes a solution on computer display without sketch.
- The weightage and distribution of marks for each Module is as shown in the following table:

Module	Max. Marks weightage	Evaluation Weightage in marks	
		Computer display & printout (a)	Preparatory sketching (b)
Module-1	20	20	0
Module-2	20	20	0
Module-3	60	60	0
Total	100	100	0
Consideration of SEE Marks		Total of [(a)/2] = Final SEE Marks	

Rubrics for CIE – Continuous assessment:					
Performance Indicators	Superior	Good	Fair	Needs Improvement	Unacceptable
Engineering Graphics Standards and CAD Sketching (P01) (20 Marks)	Accurate application of BIS standards, GD&T, threads and orthographic views (17-20)	Good understanding with minor errors (13-16)	Basic understanding (9-12)	Limited understanding (5-8)	No understanding (1-4)
Parametric Part Modelling (P01, P03, P05) (20 Marks)	Complete parametric models with correct features (17-20)	Minor modelling errors (13-16)	Acceptable models (9-12)	Incomplete models (5-8)	Incorrect models (1-4)
Assembly Modelling and Engineering Documentation (P01, P03, P05, P010) (60 Marks)	Correct constraints, exploded view and interference analysis, Accurate GD&T, BOM and standards (49-60)	Minor assembly issues, Minor documentation errors (37-48)	Functional assembly with errors, Acceptable quality (25-36)	Incomplete assembly, Poor documentation (13-24)	Incorrect assembly, Unsatisfactory documentation (1-12)

Rubrics for SEE / CIE Test:					
Performance IndicatorS	Superior	Good	Fair	Needs Improve ment	Unacceptabl e
Engineering Graphics Standards and CAD Sketchin g/ Parametric Part Modelling (C01/C02, P01, P02, P03) (20 Marks)	Fully constrained model with correct dimensions and features; no modelling errors (17-20)	Minor feature or dimensional errors (13-16)	Functional model with noticeable errors (9-12)	Incomple te model (5-8)	Incorrect or failed model generation (1-4)
Assembly Modelling and Engineering Documentation (P01, P03, P05, P010) (80 Marks)	Complete assembly with proper constraints, exploded view and interference-free operation, correct GD&T, tolerances, BOM and title block (65-80)	Minor assembly or mating errors, Minor documentation errors (49-64)	Functional assembly with moderate errors, document ation errors (33-48)	Partially assemble d model, Incomple te documen tation (17-32)	Assembly not completed, Drawing does not meet standards (1-16)

MATLAB for Engineering Computation			
Course Code	1BMEL307A	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to: 1. Use MATLAB commands and built-in functions for engineering computations and matrix-based problem solving. 2. Develop MATLAB programs using scripts, functions, decision-making statements, and loops. 3. Implement numerical methods for solving engineering mathematics problems. 4. Analyze, visualize, and interpret engineering data through graphical and regression techniques. 5. Solve differential equation models representing engineering systems using MATLAB tools. 6. Apply computational techniques to mechanical engineering problems involving vibrations and heat transfer.			
SET OF EXPERIMENTS			
1. Introduction to MATLAB Environment and Basic Computations This experiment familiarizes students with the MATLAB environment, including the Command Window, Workspace, Editor, and basic mathematical operations. Students are expected to create variables, perform arithmetic calculations, use built-in mathematical functions, and understand MATLAB syntax for engineering computations. 2. Matrix and Vector Operations This experiment introduces vectors and matrices, which form the basis of many engineering analyses. Students are expected to perform matrix addition, multiplication, transpose, inverse, determinant, and eigenvalue calculations and interpret the significance of these operations in engineering applications. 3. Solution of Simultaneous Linear Equations Students will solve systems of linear equations using matrix methods and MATLAB commands. They are expected to formulate engineering problems in matrix form, obtain numerical solutions, and verify the correctness of the results. 4. MATLAB Scripts and User-Defined Functions This experiment focuses on developing scripts and functions for engineering calculations. Students are expected to create reusable programs, pass input arguments, generate outputs, and organize calculations efficiently using modular programming techniques. 5. Control Statements and Looping Structures Students will use decision-making statements such as if-else and switch-case along with for and while loops. They are expected to develop programs involving repetitive calculations and conditional execution commonly encountered in engineering computations. 6. Numerical Solution of Nonlinear Equations This experiment introduces numerical methods for solving nonlinear equations using MATLAB. Students are expected to implement methods such as Bisection and Newton-Raphson, determine roots of engineering equations, and compare the convergence characteristics of different methods. 7. Curve Fitting and Regression Analysis Students will analyze experimental data and determine mathematical relationships using curve fitting techniques. They are expected to fit linear and polynomial models to data, evaluate fitting accuracy, and interpret the resulting equations for engineering applications. 8. Numerical Differentiation and Integration This experiment deals with the numerical evaluation of derivatives and integrals. Students are expected to apply MATLAB tools for differentiation and integration, compare numerical and analytical results, and solve engineering problems involving rates of change and accumulated quantities. 9. Solution of Ordinary Differential Equations Students will solve first-order and second-order ordinary differential equations using MATLAB solvers. They are expected to model simple mechanical systems, obtain numerical solutions, and visualize the response of engineering systems through plots. 10. Data Visualization and Graphical Representation			

This experiment introduces 2D and 3D plotting techniques for engineering data. Students are expected to generate professional-quality graphs, label axes, add legends and titles, and effectively present engineering results using graphical tools.

11. Vibration Analysis of a Spring-Mass System

Students will model and analyze the motion of a simple spring-mass system using MATLAB. They are expected to determine displacement, velocity, and acceleration responses, plot time histories, and understand the fundamentals of mechanical vibrations.

12. Heat Transfer Analysis Using MATLAB

This experiment involves solving simple heat conduction problems using MATLAB. Students are expected to calculate temperature distributions, visualize thermal profiles, and understand the application of computational methods to basic heat transfer problems encountered in mechanical engineering.

Suggested Learning Resources:

Textbooks

1. Amos Gilat, "MATLAB: An Introduction with Applications", 6th Ed., Wiley India, 2018.
2. Steven C Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists", 8th Ed., McGraw-Hill Education, 2018.

Reference Books / Manuals

1. Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving", 5th Ed., Butterworth-Heinemann (Elsevier), 2023.
2. Duane Hanselman and Bruce Littlefield, "Mastering MATLAB", Pearson Education.
3. MathWorks, MATLAB Documentation and User Guides
4. Rudra Pratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", 7th Ed., Oxford University Press, 2017.
5. William J Palm III, "Introduction to MATLAB for Engineers", 4th Ed., McGraw-Hill Education, 2020.

Web Links and Video Lectures (e-Resources):

1. MATLAB Documentation Center
<https://www.mathworks.com/help/matlab/>
2. MATLAB Official YouTube Channel
<https://www.youtube.com/@MATLAB>
3. MIT OpenCourseWare YouTube Channel
<https://www.youtube.com/@mitocw>
4. MATLAB Academy Video Courses
<https://matlabacademy.mathworks.com/>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Demonstration-Based Learning
- Hands-on Laboratory Sessions
- Problem-Based Learning (PBL)
- Case Study Approach
- Interactive Learning Activities
- Project-Oriented Learning
- Visualization-Based Learning
- Peer Learning and Collaborative Programming

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:					
Performance Indicator (CO/PO Mapping)	Superior (9-10 Marks)	Good (7-8 Marks)	Fair (5-6 Marks)	Needs Improvement (3-4 Marks)	Unacceptable (1-2 Marks)
Programming and Problem-Solving Skills	Develops complete, error-free MATLAB programs independently and obtains accurate results.	Develops programs with minor errors and obtains mostly accurate results.	Develops basic programs with some guidance; results are partially correct.	Requires significant assistance; results contain major errors.	Unable to develop programs or obtain meaningful results.
MATLAB Implementation and Computational Skills	Demonstrates excellent command of MATLAB commands, functions, and numerical methods independently.	Uses MATLAB tools correctly with minor guidance.	Uses basic MATLAB commands with limited understanding of advanced features.	Demonstrates difficulty in using MATLAB tools effectively.	Unable to use MATLAB tools and functions appropriately.
Result Analysis and Interpretation	Accurately analyzes results, presents clear conclusions, and relates findings to engineering applications.	Interprets results correctly with minor omissions.	Provides basic interpretation but lacks detailed analysis.	Interpretation is incomplete or contains significant errors.	Unable to interpret or explain results.
Laboratory Record, Documentation and Participation	Maintains complete records, submits work on time, and actively participates in all laboratory activities.	Maintains good records with minor omissions and participates regularly.	Records are partially complete; participation is satisfactory.	Records are incomplete and participation is limited.	Fails to maintain records or participate in laboratory activities.

Rubrics for SEE / CIE Test:					
Performance Indicator (CO/PO Mapping)	Superior	Good	Fair	Needs Improvement	Unacceptable
Understanding of MATLAB Concepts and Numerical Methods (10 marks)	Demonstrates comprehensive understanding of MATLAB concepts, syntax, and numerical methods; applies them correctly without assistance. (9-10 Marks)	Demonstrates good understanding with minor conceptual errors. (7-8 Marks)	Demonstrates basic understanding but requires some guidance. (5-6 Marks)	Shows limited understanding and frequent conceptual errors. (3-4 Marks)	Unable to demonstrate understanding of fundamental concepts. (1-2 Marks)
Program Development and Execution (20 Marks)	Develops complete, efficient, and error-free programs that generate accurate results. (17-20 Marks)	Develops programs with minor errors and mostly accurate results. (13-16 Marks)	Develops basic programs with some errors; results are partially correct. (9-12 Marks)	Requires substantial assistance to complete programs; results contain major errors. (5-8 Marks)	Unable to develop or execute programs successfully. (1-4 Marks)
Analysis, Interpretation and Presentation of Results (10 Marks)	Accurately analyzes outputs, interprets results logically, and presents conclusions clearly. (9-10 Marks)	Interprets results correctly with minor omissions. (7-8 Marks)	Provides basic interpretation but lacks detailed analysis. (5-6 Marks)	Interpretation is incomplete or contains significant errors. (3-4 Marks)	Unable to analyze or explain results. (1-2 Marks)
Viva Voce and Problem-Solving Ability (10 Marks)	Responds confidently and accurately to all questions; demonstrates excellent problem-solving ability. (9-10 Marks)	Responds correctly to most questions with minor prompting. (7-8 Marks)	Answers basic questions satisfactorily. (5-6 Marks)	Answers only a few questions and requires significant prompting. (3-4 Marks)	Unable to answer questions or demonstrate problem-solving skills. (1-2 Marks)

Virtual Reality			
Course Code	1BMEL307B	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
Teaching Hours/Week (L :T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Explain the basic concepts of Virtual Reality and its relevance in Mechanical Engineering. 2. Import and visualize CAD models in VR environments. 3. Apply VR tools for product visualization, manipulation and assembly. 4. Develop simple interactive VR environments for mechanical components. 5. Evaluate VR as a tool for design communication and simulation.			
SET OF EXPERIMENTS			
1. Introduction to VR systems, hardware, and navigation 2. Importing CAD models (from AutoCAD / SolidWorks / Fusion 360) into VR platforms and optimizing 3. Lights, Material application and visualization 4. Scene creation and basic interaction in VR 5. Blueprint creation 6. Animation and walkthrough experience in VR 7. VR-based assembly simulation 1 8. VR-based assembly simulation 2 9. Product visualization project 10. Interactive mechanical model 11. Mini Project Part 1: Design a mechanical component/s and develop the interactive VR environment for the mechanical component 12. Mini Project Part 2: Design a mechanical component/s and develop the interactive VR environment for the mechanical component			
Suggested Learning Resources: Textbooks: 1. Steven M LaValle , “Virtual Reality”, Cambridge University Press, 2023 2. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application, and Design”, 2nd Ed., Morgan Kaufmann, 2018 Reference books / Manuals: https://dev.epicgames.com/documentation/ • Unreal Engine Documentation • Twinmotion Learning Guides			
Web links and Video Lectures (e-Resources): • Unreal Engine Learning Portal- https://dev.epicgames.com/community/unreal-engine/learning • https://docs.unrealengine.com • https://developer.oculus.com • https://www.blender.org/support/tutorials/ YouTube: CAD to VR workflows • https://youtu.be/i3xNb5R_xos • https://youtu.be/kM27HYbpvc0 • https://youtu.be/fiQ2OgEBbkC • https://www.udemy.com/course/unreal-engine-5-for-games-physics/			

- <https://www.udemy.com/course/unreal-engine-5-blueprints-game-developer-masterclass/>

Software Required:

1. CAD SOFTWARE (PREREQUISITE)
 - AutoCAD/ SolidWorks / Fusion 360 / Creo
2. VR & VISUALIZATION SOFTWARE
 - Twinmotion
 - Unreal Engine
 - Unity
3. FILE PIPELINE / CONNECTORS
 - Datsmith Plugin (for CAD → Unreal workflow)
 - FBX / OBJ exporters

HARDWARE REQUIRED:

- VR Headsets (Meta Quest 2 / 3 or equivalent)
- High-performance PC (RTX GPU recommended)

1. CPU: AMD Ryzen Threadripper 3970X or Intel Core i9-13900K (at least 12 cores, 24 threads)
 GPU: NVIDIA GeForce RTX 4090 or AMD Radeon RX 7900 XTX (with at least 24 GB of VRAM)
 RAM: 64 GB of DDR5 RAM (or more)
 Storage: Fast NVMe SSD (at least 2 TB)
 Motherboard: Compatible with your CPU and has features like Wi-Fi, USB 3.2 Gen 2, and high-quality audio. Preferred Computers are **Precision 3660 Tower Workstations. Alienware Aurora R16 Gaming Desktop or higher-end PC for 3d visualizations and the latest versions of Unreal Engine.**

2. META Quest 3 VR Headset Motion Controller (White, For PC, PS4, Xbox)

- 512GB of Internal Storage
- Full-Color Passthrough
- Elite Strap Included
- 2064 x 2208 Resolution
- XR2 Gen 2 Snapdragon Processor
- Ring-Free Touch Plus Controllers
- TruTouch Haptic Feedback
- Built-In 3D Spatial Audio

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Hands-on lab-based learning
2. CAD to VR workflow demonstration
3. Project-based learning

Assessment Structure:

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

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

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

Semester End Examination: Virtual Reality for Mechanical Engineers**Total Marks:** 50 | **Time:** 3 Hours**PART – A: VR Fundamentals & Asset Integration (20 Marks)***Instructions: Answer any **two** out of the following four questions. (10 Marks each)*

Asset Optimization & Import: Export a moderately complex assembly (at least 5 to 10 components) from SolidWorks/Fusion 360. Import it into a VR platform (Unity/Unreal). Demonstrate optimization by reducing the poly-count or managing the hierarchy to ensure a stable frame rate. Apply realistic metallic and matte materials to the components.

Environment & Lighting: Create a "Virtual Workshop" scene. Place a mechanical workstation in the center. Configure **Global Illumination** and at least two local light sources (Point/Spot) to highlight the mechanical features of your model. Ensure no light leakage through mesh walls.

Navigation & Basic Blueprinting: Develop a VR scene where the user can move using **Teleportation** and **Snap Turn** mechanics. Create a basic Blueprint/Script where clicking a "Start" button changes the color of a specific mechanical part to indicate it is "Active."

Animation & Walkthrough: Create a guided walkthrough experience. Program a camera path or a character movement that takes the viewer through the internal cross-section of a large mechanical system (e.g., an engine block or a turbine).

PART – B: Immersive Engineering Applications (30 Marks)*Instructions: Perform **one** of the following Mini-Project simulations. (30 Marks)***Interactive Assembly Simulation:**

Design a simple 3-part assembly (e.g., Bolt, Washer, Nut).

In the VR environment, implement **Grab Interactors**.

The user must be able to pick up the parts and "snap" them into the correct assembly sequence.

Mechanical Model Interaction (Mini-Project):

Design a mechanical component (e.g., a Gearbox or Piston-Cylinder).

Develop a VR experience where the user can trigger an "Exploded View" animation using a trigger press.

Rubrics for CIE – Continuous assessment:					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Understanding of VR Concepts and Workflow (P01)	Clearly explains the concepts, workflow, and applications of VR tools and CAD integration with appropriate technical terminology.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding of the concepts and workflow.	Demonstrates limited understanding with several inaccuracies.	Unable to explain the concepts or workflow.
Observation and Interpretation (P02)	Accurately records observations, explains outcomes, and relates them to the objectives of the experiment.	Records observations correctly with minor omissions in interpretation.	Records basic observations with limited explanation.	Observations are incomplete or inaccurate with poor interpretation.	Fails to record meaningful observations or interpretations.
Documentation (P09)	Record is complete, well-organized, and includes objectives, procedure, screenshots, observations, and conclusions for all experiments.	Record is complete with minor omissions or formatting issues.	Record contains most essential sections with acceptable organization.	Record is incomplete or poorly organized with several missing sections.	Record is inadequate or not submitted.
Use of Figures, Screenshots and Technical Presentation (CO3/P09)	Includes clear screenshots, annotated figures, and well-formatted content that effectively supports the report.	Includes appropriate figures and screenshots with minor presentation issues.	Includes basic figures/screenshots with acceptable presentation.	Limited or poorly presented figures/screenshots.	No relevant figures or screenshots included.

Rubrics for SEE / CIE Test:					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
CAD Model Integration and VR Environment Development (P01, P02)	CAD models are accurately imported, optimized, and integrated into a well-structured VR environment with appropriate scene organization.	CAD models are correctly integrated with minor issues in optimization or scene organization.	CAD models are integrated with basic functionality and acceptable organization.	CAD integration is incomplete or contains significant errors.	Unable to import or integrate CAD models into the VR environment.
Application of VR Features and Interactivity (P02, P03)	Effectively implements lighting, materials, animations, Blueprints, navigation, and interactive features to create an immersive VR experience.	Implements most VR features correctly with minor functional issues.	Implements basic VR features with limited interactivity.	Implements few VR features with frequent errors.	Fails to implement essential VR features or interactivity.
Assembly Simulation / Product Visualization (P03, P04)	Successfully develops an accurate assembly simulation or product visualization demonstrating correct sequence, functionality, and engineering relevance.	Develops a functional assembly simulation/product visualization with minor deficiencies.	Develops a basic assembly simulation/product visualization with limited functionality.	Develops an incomplete or partially functional simulation.	Unable to demonstrate assembly simulation or product visualization.
Technical Quality and Engineering Application (P02, P04)	Demonstrates excellent engineering understanding, realistic visualization, and effective application of VR to solve engineering problems.	Demonstrates good engineering application with minor limitations.	Demonstrates satisfactory engineering application with basic understanding.	Demonstrates limited engineering understanding and application.	Demonstrates poor understanding of engineering application.
Demonstration, Viva Voce and Technical Communication (P09)	Demonstrates the project confidently, explains workflow and design decisions clearly, and answers viva questions accurately.	Demonstrates the project well with minor communication gaps.	Demonstrates the project with acceptable explanation and responses.	Demonstration lacks clarity and responses are partially correct.	Unable to explain the project or respond to viva questions satisfactorily.

Spreadsheet for Engineers			
Course Code	1BMEL307C	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Create various plots and charts, and compute mathematical functions for data interpretation. 2. Apply iterative techniques to solve roots, perform optimization, and carry out non-linear regression analysis. 3. Perform matrix operations and apply numerical methods such as integration and solving differential equations using computational tools. 4. Develop and implement VBA programs including User Defined Functions (UDFs), subroutines, and macros to automate engineering computations.			
SET OF EXPERIMENTS			
Sl. No.	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 and XOR functions.		
4.	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.		
5.	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.		
6.	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.		
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, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.		
8.	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.		
Demonstration Experiments (For CIE)			
9.	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.		
10.	Differential Equations: Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation		
Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):			
1. McFedries Paul, "Microsoft Excel 2019 Formulas and Functions" Microsoft Press, U.S, 2019. 2. Joan Lambert and Curtis D Frye, "Microsoft Excel Step by Step", Pearson Education, 2022.			
Web links and Video Lectures (e-Resources):			
https://www.youtube.com/watch?v=q02ROKSTGBY			
Teaching-Learning Process (Innovative Delivery Methods):			
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.			
1. Flipped Classroom with pre-lab video resources 2. Demonstration-based and hands-on learning 3. Problem-based and case-based learning approaches 4. Mini projects and open-ended experiments			

5. ICT-Enabled Teaching
6. Peer learning and collaborative activities
7. Exposure to industry tools like Excel Solver and VBA

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Concept Understanding & Application (C01/P01)	Complete understanding of concepts	Good understanding with minor conceptual errors	Basic understanding but limited application	Partial understanding with incorrect application	No clear understanding
Problem Solving & Numerical Methods (C02/P02,3)	Accurately applies iterative, optimization, and regression technique	Minor mistakes in approach or calculation	Uses correct method but incomplete execution	Incorrect method selection or major errors	Unable to solve problems
Computational Implementation (Excel/VBA) (C03,4/P03,5)	Efficient implementation of Excel tools, matrix, VBA	Correct implementation with minor issues	Basic implementation with limited efficiency	Errors in coding or formula usage	Unable to implement
Data Analysis & Interpretation (C01,2/P04)	Insightful analysis of graphs, regression, and results	Good interpretation with minor gaps	Basic analysis without depth	Incorrect or weak interpretation	No analysis
Lab Record, Presentation & Documentation (C04/P09, 10)	Complete with explanation of results	Organized with minor missing details	Acceptable but lacks clarity	Poor organization	Incomplete / missing

Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (C01/P01)	Clearly understands problem independently	Minor clarifications needed	Partial understanding	Misinterprets problem	No understanding
Solution Approach (C02/P02)	Optimal method selected correctly	Good method with minor inefficiencies	Basic method	Incorrect approach	No approach
Execution (Excel/VBA) (C03,4/P03,5)	Accurate implementation (Excel/VBA/tools)	Minor execution errors	Partial execution	Major errors	Student has not understood the concepts clearly
Output & Accuracy (C02/P04)	Correct results with validation	Minor deviations	Partially correct	Incorrect results	No output
Viva-Voce (C01-4/P09)	Answers confidently with deep knowledge	Good understanding	Basic answers	Limited responses	Unable to answer

Prompt Engineering			
Course Code	1BMEL307D	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	III
Teaching Hours/Week (L :T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L :T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcomes (Course Skill Set) At the end of the course, the student will be able to: • Explain the fundamentals of Artificial Intelligence. • Design effective prompts for engineering problem-solving. • Apply AI tools for CAD, simulation, thermodynamics and manufacturing tasks. • Analyze mechanical systems using AI-assisted reasoning. • Develop domain-specific prompts for design optimization and analysis. • Demonstrate problem-solving using prompt engineering in real-world ME scenarios.			
SET OF EXPERIMENTS			
1. Introduction to AI Tools (ChatGPT, Gemini) 2. Zero-Shot Prompting: Writing prompts for Thermodynamics problems 3. One-Shot Prompting: Solving of Strength of Materials numerical problems 4. Few-Shot Prompting: Heat transfer concepts 5. Role-Based Prompting: Using AI for CAD design idea generation (AutoCAD/SolidWorks concepts) 6. Instruction-Based Prompting: Prompt engineering for Manufacturing Processes (casting, welding, machining) 7. Iterative Prompting: Error analysis and refinement of engineering solutions 8. Develop AI prompt for the datasets given. 9. Design a prompt to optimize a heat exchanger system 10. Develop AI prompts for failure analysis of mechanical components 11. Develop AI prompts for inspection of cad model and final machined part using image files. 12. Create prompts for predictive maintenance using sensor data 13. Generate AI-based design concepts for sustainable mechanical systems			
Suggested Learning Resources: Textbooks: 1. Russell S & Norvig P, "Artificial Intelligence: A Modern Approach", 3rd Ed., Pearson, 2020. 2. Phoenix J & Taylor M, "Prompt Engineering for Generative AI", O'Reilly, 2024. 3. Tabatabaian M, "Prompt Engineering Using ChatGPT", Mercury Learning, 2024. 4. Hibbeler R C, "Engineering Mechanics: Statistics & Dynamics," 15th Ed., Pearson, Latest Edition. Reference books / Manuals: 1. Ian Khan, "The Quick Guide to Prompt Engineering", Wiley, 2024. 2. Sharma R C & Bozkurt A, "Transforming Education with Generative AI", IGI Global, 2024. 3. Chip Huyen, "AI Engineering", O'Reilly, 2024.			
Web links and Video Lectures (e-Resources): • https://www.promptingguide.ai • https://openai.com • https://towardsdatascience.com YouTube Links: • https://www.youtube.com/watch?v=YhRfgYH_AoU • https://www.youtube.com/watch?v=n0VpK1RfYGA • https://www.youtube.com/watch?v=AgGu96_rnXo&list=PLYio3GBcDKsPP2_zuxEp8eCulgFjI5a3g • https://www.youtube.com/watch?v=BzIF4hrEgyk			

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Hands-on Learning using AI Tools:**2. Problem-Based Learning (PBL) using Mechanical Case Studies****Assessment Structure:**

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

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

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

Rubrics for CIE – Continuous assessment:

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Concept Understanding & AI Tool Application (P01)	Demonstrates comprehensive understanding of AI tools, prompting techniques, and their engineering applications.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding with limited application.	Demonstrates partial understanding with incorrect application.	Demonstrates little or no understanding of AI concepts.
Prompt Design and Engineering (P02, P03)	Develops clear, well-structured, and context-specific prompts that consistently generate relevant engineering solutions.	Develops effective prompts with minor improvements needed.	Develops basic prompts that produce partially relevant outputs.	Develops incomplete or ambiguous prompts with limited effectiveness.	Unable to formulate meaningful prompts.
AI-Based Problem Solving and Refinement (P03, P04)	Effectively applies iterative prompting to solve engineering problems, refine AI outputs, and justify improvements.	Solves engineering problems using AI with minor refinements required.	Solves basic problems with limited refinement of AI responses.	Requires significant guidance to obtain acceptable AI outputs.	Unable to use AI effectively for engineering problem solving.
Analysis and Interpretation	Critically analyses AI-	Correctly interprets AI	Provides basic	Interpretation is weak or	Unable to analyse or

of AI Outputs (P04)	generated responses, identifies limitations, validates results, and provides sound engineering interpretation.	outputs with minor omissions.	interpretation with limited validation.	partially incorrect.	interpret AI-generated results.
Laboratory Record, Prompt Documentation & Presentation (P09, P010)	Laboratory record is complete, well-organized, and includes prompts, AI outputs, observations, refinements, conclusions, and proper documentation.	Record is complete with minor omissions or presentation issues.	Record contains essential information but lacks clarity or detail.	Record is incomplete, poorly organized, or lacks proper documentation.	Record is inadequate or not submitted.

Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (P01)	Clearly understands the engineering problem and independently identifies the appropriate AI prompting strategy.	Understands the problem with minor clarifications.	Demonstrates basic understanding but requires guidance.	Partially understands or misinterprets the problem.	Unable to understand the problem.
Prompt Design and Solution Strategy (P02, P03)	Develops well-structured, context-specific prompts and selects the most appropriate prompting technique to obtain accurate engineering solutions.	Develops appropriate prompts with minor deficiencies in structure or strategy.	Develops basic prompts that produce partially relevant responses.	Develops incomplete or ineffective prompts requiring significant guidance.	Unable to formulate meaningful prompts or solution strategy.
Prompt Refinement and AI Tool Utilization (P03, P05)	Effectively uses AI tools and iterative prompting to refine responses, improve solution quality, and accomplish the assigned engineering task.	Uses AI tools correctly with minor refinements needed.	Uses AI tools with basic prompting and limited refinement.	Uses AI tools with frequent errors or ineffective prompting.	Unable to use AI tools effectively for the assigned task.
Output Analysis and Engineering Interpretation (P04)	Critically analyses AI-generated outputs, validates engineering relevance, identifies limitations, and provides	Correctly interprets outputs with minor omissions or inaccuracies.	Provides basic interpretation with limited engineering validation.	Interpretation is incomplete or technically weak.	Unable to analyse or interpret AI-generated outputs.

	appropriate conclusions.				
Viva-Voce (P09)	Answers confidently with comprehensive understanding of AI tools, prompting techniques, engineering applications, and limitations.	Demonstrates good understanding with minor conceptual gaps.	Provides basic answers with acceptable understanding.	Responds with limited understanding and requires prompting.	Unable to answer questions satisfactorily.

Complex Analysis and Probability Distributions			
Course Code	1BMATM401	Scheme	2025
Type of Course	ASC	Semester	IV
Teaching Hours/Week (L: T: P)	2:2:0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:0:24:24	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03
At the end of the course, the student will be able to: C01: Apply concepts of complex analysis, Cauchy-Riemann equations, Milne-Thomson method, and harmonic functions to construct and analyze analytic functions in engineering applications. C02: Apply Laplace Transform to solve ODE' S and PDE'S of Engineering Problems. C03: Apply probability distributions and joint probability concepts to model and analyze uncertainties encountered in mechanical engineering systems. C04: Utilize sampling theory, hypothesis testing, and Markov chain models for statistical inference and stochastic system analysis. C05: Analyze engineering reliability and queueing problems using statistical measures, queueing models, and reliability indices for performance evaluation and decision-making.			
Module-1: Complex Analysis			
Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms. Construction of analytic functions: Milne-Thomson Method-Problems, Harmonic Functions-Problems.			
			Number of Hours: 9
Module-2: Laplace Transforms			
Laplace Transform: Definition and Laplace transform of elementary functions (statements only) Problems on Properties: $L[f(at)] = \left(\frac{1}{a}\right) \bar{f}\left(\frac{s}{a}\right)$, $L[e^{at}f(t)] = \bar{f}(s-a)$, $L[t^n f(t)] = (-1)^n \frac{d^n}{ds^n} [\bar{f}(s)]$, $L\left[\frac{f(t)}{t}\right] = \int_s^\infty \bar{f}(s) ds$. Laplace transforms of unit-step function – problems. Inverse Laplace Transform: Definition and problems on inverse Laplace transforms (without Proof). Solution of linear ordinary differential equations using Laplace transforms.			
			Number of Hours: 9
Module-3: Probability Distributions			
Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Binomial, Poisson and normal distributions- problems.			
Joint Probability Distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.			
			Number of Hours: 8
Module-4: Sampling theory			
Sampling theory: Sampling, Sampling distributions, standard error, Type I and Type II errors, Level of significance, confidence limits for means, one tailed and two tailed tests, test of hypothesis (Single mean, Single proportion, difference of means and difference of proportions), student's t-distribution, Chi-square distribution (goodness of fit of poison),			
			Number of Hours: 8
Module-5: Markov Chain, Queueing Theory and Reliability Engineering			
Stochastic Process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-problems.			
Queueing Theory: Problems on Queueing model with M/M/1 (No derivation)			
Reliability Engineering: Reliability of systems, Problems on MTTF, MTBF. (No derivations).			
			Number of Hours: 8

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

1. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", 12th Ed., S. Chand Publishing.
2. R K Jain and S R K Iyengar, "Advanced Engineering Mathematics", 5th Ed., Narosa Publishing House.
3. B S Grewal, "Higher Engineering Mathematics", 45th Ed., Khanna Publishers.

Reference books / Manuals:

1. B V Ramana, "Higher Engineering Mathematics", Mc Graw-Hill Education, 2017
2. M R Spiegel, J Schiller, and R A Srinivasan, "Schaum's Outline of Probability and Statistics", McGraw Hill.
3. S P Gupta, "Statistical Methods", 46th Ed., Sultan Chand & Sons, 2023.
4. V K Rohatgi and A K Md. Ehsanes Saleh, "An Introduction to Probability and Statistics", 2nd Ed., Wiley

Web links and e-Resources:

- <https://nptel.ac.in/courses/111105160>
- <https://nptel.ac.in/courses/127106019>
- <https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/>
- <https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/pages/syllabus/>

Teaching-Learning Process (Innovative Delivery Methods):

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

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self-study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to learn groups to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:
 - As an introduction to new topics (pre-lecture activity).
 - As a revision of topics (post-lecture activity).
 - As additional examples (post-lecture activity).
 - As an additional material of challenging topics (pre-and post-lecture activity).
 - As a model solution of some exercises (post-lecture activity).

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.

To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.

To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.

Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 or RBL4 levels) for Teamwork	10
2.	GATE-based Aptitude Test	15

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar on Complex Analysis	5
2.	MATLAB/Python Simulation of Laplace-Transform problems	5
3.	Mini Project on statistical Models in Engineering Applications	9
4.	Case Study on Signal Processing using Transform Techniques	5
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1	MOOCs/NPTEL Courses	24

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

1. Sample Rubrics - Mini-Project

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition & data	Clear, relevant engineering questions; data source and limitations documented.	Mostly clear; minor gaps in context or data description.	Vague questions or poorly documented data.	10%
Data processing & descriptive statistics	Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.	Mostly correct; minor computational errors.	Significant errors, missing key measures or plots.	25%
Probabilistic modelling (distributions, inference)	Appropriate distributions and tests used; assumptions stated; results interpreted in context.	Reasonable choice of models; some assumptions implicit; interpretation mostly sound.	Inappropriate or poorly justified models; limited interpretation.	30%
Engineering insight / risk framing	Clear link to design/assessment decisions, safety and uncertainty; limitations discussed.	Some discussion of implications; limited treatment of limitations.	Minimal engineering interpretation on beyond numbers.	20%
Report & communication	Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation.	Acceptable structure; some clarity issues; presentation adequate.	Disorganized or incomplete report; weak presentation.	15%

Students' activities for TW/SL under NCrF: Samples only

As per National credit formwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/SL-50 hours). Hence, students must complete minimum of two activities as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Continuous Internal Evaluation (CIE)

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

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

Passing requirement in SEE

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

Fluid Mechanics & Machinery			
Course Code	1BMR402	Scheme	2025
Type of course	IPCC	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:28:25:25	SEE Marks	50
Credits	4	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	3
Course Outcome (Course Skill Set): At the end of the course, the student will be able to: 1. Describe the fundamental concepts and principles of fluid mechanics and machinery. 2. Explain the fluid dynamics relations for different engineering applications. 3. Apply the governing laws of fluid mechanics for different engineering applications. 4. Analyse the various fluid flow processes and turbomachines.			
Module-1			
Introduction: Definition and properties, types of fluids, pressure at a point in static fluid, variation of pressure, Pascals Law. (To be reviewed in class but not for examination) Pressure- Absolute, gauge, vacuum, pressure measurement by manometers and gauges, hydrostatic pressure on plane submerged bodies. Buoyance and metacentre, Stability of submerged bodies. Fluid Kinematics: Types of fluid flow, streamlines, pathlines and streaklines, continuity equation, stream function & potential function.			
			Number of Hours: 9
Module-2			
Fluid Dynamics: Introduction, Forces acting on fluid in motion, Linear momentum equation, Impact of jets, Euler's equation of motion along a streamline. Bernoulli's equation – assumptions and limitations. Introduction to Navier Stokes equation, Venturi meters, orifice meters, rectangular and triangular notches, pitot tubes, Rotameter.			
			Number of Hours: 8
Module-3			
Laminar and turbulent flow: Dimensionless numbers, Flow through circular pipe, Poiseuille equation, Flow between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow. Turbulence: Characteristics of turbulent flow, laminar turbulent transition, major and minor losses, Development of boundary layer, Lift and Drag.			
			Number of Hours: 8
Module-4			
Introduction to Turbo machines: Classification of Turbomachines, Basic constructional details, Euler's equations for a Turbo machine, Impulse & Reaction machine, Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines. Hydraulic Turbines: Classification of hydraulic turbines, Principle of working, velocity triangles - Pelton wheel - Francis turbine, Kaplan turbine, design parameters and numerical problems, Draft tubes.			
			Number of Hours: 9
Module-5			
Centrifugal and Axial flow Pumps: Main Parts of centrifugal pump, basic terms and definitions, velocity triangles, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH, multistage pumps. Axial flow Pumps – characteristics – constructional detail.			
			Number of Hours: 8

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer.
2. Measurement of pressure using different Manometers for high- and low-pressure measurements (manometers using different manometric fluids).
3. Working principle of different flow meters and their calibration (orifice plate, Venturi meter, turbine, Rota meter, electromagnetic flow meter).
4. Working principle of different flow meters for open channel and their calibration.
5. Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness.
6. Effect of change in cross section and application of the Bernoulli equation.
7. Impact of jet on flat and curved plates.
8. Performance test on Pelton turbine and draw main and operating characteristics.
9. Performance test on Francis turbine and draw main and operating characteristics.
10. Performance test on Kaplan turbine and draw main and operating characteristics.
11. Performance test on single / multi-stage centrifugal pump.
12. Reynolds apparatus to measure critical Reynolds number for pipe flows (Demonstration).
13. Determination of drag and lift co-efficient of standard objects using wind tunnel (Demonstration).

Suggested Learning Resources:

Textbooks:

1. Cimbali J M, Cengel Y A, “Fluid Mechanics: Fundamentals and Applications”, 5th Ed., McGraw-Hill, 2010.
2. R K Rajput, “Fluid Mechanics and Hydraulic Machines”, S Chand & Company, 2016.
3. Dr. R K Bansal, “A textbook of Fluid Mechanics and Hydraulic Machines”, 11th Ed., Laxmi Publications (P) Ltd., 2010.
4. Dr. M S Govinde Gowda, “A Text Book of Turbomachines”, Iterative International Publishers, 2024.

Reference Books / Manuals:

1. R C Hibbeler, “Fluid Mechanics”, 2nd Ed., Pearson Education, 2022.
2. Anup Goel and Harshad S Patel, “Turbo Machines”, Technical Publications, 2021.
3. Bruce R Munson, Theodore H Okiishi, Wade W Huebsch and Alric P Rothmayer, “Fundamentals of Fluid Mechanics”, 7th Ed., John Wiley & Sons Inc., 2012.

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/105103192>
2. <https://nptel.ac.in/courses/112105206>
3. <https://nptel.ac.in/courses/112104118>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Simulation and Virtual Labs
- ICT-Enabled Teaching

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each). The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

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

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

CIE Practical component:

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

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

Continuous Internal Evaluation (CIE)**(i) Theory component**

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

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

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

(ii) Laboratory component

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

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

(i) To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

Passing requirement in SEE

For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Table – ICs/IPCCs 1 Distribution of marks		
Component	Description	Marks
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
Subtotal		15
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
Subtotal		10
Total		25

Rubrics for Practical CIE – Continuous Assessment:

Performance Indicator (COs/POs)	Superior	Good	Fair	Needs Improvement	Unacceptable
Ability in Conducting Experiments (CO3/PO2, PO3, PO4, PO8) (10 Marks)	Demonstrates excellent understanding of the experiment, independently prepares specimens, safely operates equipment, follows procedures accurately, records observations systematically, actively participates in the experiment and analyse the results effectively (9 – 10 Marks)	Performs the experiment correctly with minimal guidance, follows safety practices, and records observations with only minor errors. (7 - 8 Marks)	Performs the experiment satisfactorily with occasional guidance, follows procedures adequately, and records acceptable observations (5 - 6 Marks)	Requires frequent assistance in conducting the experiment, shows limited understanding of equipment/procedure, and records incomplete or inaccurate observations. (3 – 4 Marks)	Unable to perform the experiment independently, does not follow procedures or safety practices, and fails to obtain or record meaningful observations. (1 - 2 Marks)
Laboratory Record / Journal (PO9) (20 Marks)	Record book is complete, neat, and well-organized with objectives, theory, procedure, observations, calculations, graphs/microstructures, results, discussion, and precautions.	Record book is complete with good presentation; minor omissions or formatting errors; calculations and results are mostly accurate;	Record book contains all essential sections but lacks detail in presentation, analysis, or interpretation; few calculation or recording errors.	Record book is incomplete, poorly organized, contains several errors or missing sections, and/or delayed submission. (5 - 8 Marks)	Record book is largely incomplete, inaccurate, poorly maintained, or not submitted. (2 - 4 Marks)

	Results are accurate and submitted on time. (17 – 20 Marks)	submitted on time. (13 – 16 Marks)	(9 - 12 Marks)		
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Term Work (TW) and Self Learning (SL) components in Number of hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Mini Project (Design/Analysis of a Simple Piping System, Hydraulic System, or Marine Fluid Handling System)	15
2.	Industrial Visit / Laboratory Visit Report on Pumping Station, Water Treatment Plant, Hydropower Plant, Shipyard, or Marine Engineering Facility	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	MOOCs/NPTEL Courses/Video Lectures	25

Theory of Machines			
Course Code	1BAU403	Scheme	2025
Type of Course	PCC	Semester	IV
Teaching Hours/Week (L:T:P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy per semester L:T:P:SL:TW	42:28:0:35:15	SEE Marks	50
Credits	04	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. identify and enumerate different link-based mechanisms with basic understanding of motion, types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems. 2. Explain the causes and effects of vibration in mechanical systems. 3. Develop schematic models for physical systems and formulate governing equations of motion and vibrations. 4. To analyse the mathematical models and to determine its response of real-life engineering systems.			
Module-1			
Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, Velocity and Acceleration analysis of planar mechanisms. Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.			
Number of Hours: 9			
Module-2			
Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism, shaper mechanism. Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism, shaper mechanism. Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine.			
Number of Hours: 8			
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, condition and expressions for minimum number of teeth to avoid interference. Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.			
Number of Hours: 8			
Module-4			
Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in the same plane and in different planes. Balancing of several rotating masses by balancing masses in the same plane and in different planes. Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.			
Number of Hours: 9			
Module-5			
Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations-Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom Systems. Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.			
Forced vibrations: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed.			
Number of Hours: 9			

Suggested Learning Resources:**Textbooks:**

1. Rattan S S, "Theory of Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Ltd., 2009.
2. Sadhu Singh, "Theory of Machines", 2nd Ed., Pearson Education Inc., 2006.
3. V P Singh, "Mechanical Vibrations", 3rd Ed., Dhanpat Rai & Company, 2006.

Reference books / Manuals:

1. S S Rao, "Mechanical Vibrations", 4th Ed., Pearson Education Inc., 2003.

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/112105268>
2. <https://nptel.ac.in/courses/112106270>
3. <https://nptel.ac.in/courses/112101096>
4. <https://nptel.ac.in/courses/112103111>
5. <https://nptel.ac.in/courses/112107212>
6. <https://nptel.ac.in/courses/112107087>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Video demonstrations
- Simulations.
- Flipped Classroom
- Problem-Based Learning (PBL)
- Group Learning

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks, i.e., 20 marks.**
- To pass the **SEE**, a student must score at least **35% of 50 marks, i.e., 18 marks.**
- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks.**

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks.**

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks.** It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students.** These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Case Study Presentation on Applications of Mechanisms, Gear Trains, Governors, and Flywheels in Mechanical Systems.	10
2.	Kinematic and Dynamic Analysis of Mechanical Systems – Technical Report	15

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1 Case Study Presentation on Applications of Mechanisms, Gear Trains, Governors, and Flywheels in Mechanical Systems.					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Understanding of Mechanical Systems (P01)	Demonstrates comprehensive understanding of the selected mechanical system and its components	Good understanding with minor gaps	Basic understanding	Limited understanding	Unable to explain the system
Application of Kinematic and Dynamic Principles (P02)	Correctly explains the application of kinematic and dynamic principles to the selected system	Mostly correct explanation	Partial application	Minimal application	No application of concepts
Case Study Analysis and Interpretation (P02, P04)	Presents comprehensive analysis with appropriate interpretation and engineering justification	Good analysis with minor omissions	Adequate analysis	Limited analysis	No meaningful analysis
Presentation and Technical Communication (P010)	Well-organized, technically sound, and confidently presented	Good presentation with minor errors	Average presentation	Poor organization and communication	Unable to present effectively
Team Participation and Collaboration (P09, P010)	Highly active and collaborative throughout the activity	Good participation	Moderate participation	Limited participation	No participation

Rubrics for Learning Activity 2 Kinematic and Dynamic Analysis of Mechanical Systems – Technical Report					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Selection and Understanding of Mechanical System (P01)	Appropriately selects the mechanical system and demonstrates comprehensive understanding of its working principles	Appropriate selection with good understanding	Basic understanding of the selected system	Limited understanding	Unable to explain the selected system
Kinematic and Dynamic Analysis (P02)	Performs accurate and comprehensive kinematic and dynamic analysis with proper engineering justification	Mostly accurate analysis with minor errors	Partial analysis	Limited analysis	Unable to perform the analysis
Interpretation of Results (P02, P04)	Correctly interprets results and provides meaningful engineering conclusions	Good interpretation with minor omissions	Adequate interpretation	Limited interpretation	No meaningful interpretation
Technical Report Quality (P010)	Well-structured, technically sound, and professionally presented	Good structure with minor errors	Average quality	Poor organization	Incomplete report
Presentation of Findings (P010)	Presents findings clearly with confidence and effectively responds to queries	Good presentation with minor deficiencies	Average presentation	Poor presentation	Unable to present findings

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Case Study	15
2.	Technical Report	20
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Video Lectures	15

Marine Electrical Technology			
Course Code	1BMR404	Scheme	2025
Type of Course	PCC	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:0:0:24:24	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Describe ships electrical systems, power distribution systems, motor construction, protection, lighting, and battery services. 2. Explain AC and DC generator systems, protections and circuit breakers, communication systems, and various testing equipment used in marine electrical systems. 3. Examine and compare electrical generation systems, distribution systems, motor protection, lighting systems, battery systems, safety measures, and insulation practices. 4. Evaluate the performance, safety, and maintenance requirements of marine electrical machines and systems.			
Module-1			
Ships' Electrical Systems: Introduction to DC and AC systems used on board ships. AC Generators: Rotating alternating current generator, construction and cooling, excitation methods, and automatic voltage regulation. Generators in Parallel: Synchronization and generator protection. Emergency Generators: Location, electromagnetic compatibility, and SOLAS requirements for emergency generators.			
			Number of Hours: 9
Module-2			
Power Distribution Systems: 380 V, 440 V and 240 V systems; insulated and earthed neutral systems. Switchboards and Control Gear: Switchboards, combination of switch and control gear, circuit breakers, magnet switches, MSB protection, and significance of earth faults. Transformers and Shore Supply: Transformers, instrument transformers, shore supply connection, and non-essential trips. Cables and Design Criteria: Cables, types and requirements, cable tracks, sealing when cables penetrate bulkheads, load balance, and short-circuit calculation. Diagrams and Safety Zones: Block, system, line and circuit diagrams; dangerous zones 0, 1 and 2; power management systems; and dead man alarm system of the engine room.			
			Number of Hours: 8
Module-3			
Motors: Introduction, motor construction, IP protection/ratings, and induction motor operation. Starters and Control: Control equipment, direct-on-line starting, reduced voltage starting, speed control, and motor protection. Single Phase Motors: Maintenance. Hazardous Area Protection: Flameproof enclosures for light fittings and motors on tankers, intrinsically safe circuits, increased safety, non-sparking, pressurized enclosure, and special protection. Certification and Identification: Markings.			
			Number of Hours: 8
Module-4			
Electrical Services: Introduction, ships' lighting, incandescent lamps, discharge lamps, and voltage effects on lighting. Lighting Systems: Navigation and signal lights, emergency lighting, and maintenance of lighting. Batteries and Power Supply: Types of batteries, battery supplies, UPS, emergency generators, and emergency power for cargo ships. Internal Communication Systems: Talk-back system, sound-powered telephone system, and automatic telephone installations. External Communication Systems: Ship-shore communication system and Global Maritime Distress and Safety System.			
			Number of Hours: 8
Module-5			
Safety and Maintenance of Electrical Systems: General electrical maintenance, fault finding, generator maintenance, and overhauling of motors when insulation is zero.			

Circuit Calculations and Diagrams: Circuit calculations and electrical diagrams.

Electrical Safety and Testing: Electric shock, insulation resistance, circuit testing, insulation testing, and continuity testing.

Testing Instruments: Multimeter, diode tests, current clamp meters, and live-line testers.

Battery Maintenance: Maintenance of batteries and precautions to be taken for the battery room.

Number of Hours: 9

Suggested Learning Resources:

Textbooks:

1. Elstan A Fernandez, "Marine Electrical Technology", 14th Ed., Shroff Publishers & Distributors Pvt. Ltd., 2022.
2. Christopher Lavers and Edmund G R Kraal, "Advanced Electrotechnology for Marine Engineers", Reeds Vol. 07, 3rd Ed., Bloomsbury Publishing, 2014.
- 3.

Reference books / Manuals:

1. H. D. McGeorge, "Marine Electrical Equipment and Practice", 2nd Ed., Butterworth-Heinemann, 1993.
2. Surinder Pal Bali, "Electrical Technology: Electrical Fundamentals", Vol. I, Pearson, 2013.
3. Surinder Pal Bali, "Electrical Technology: Machines and Measurements", Vol. II, Pearson, 2013.

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/108105155>
- <https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html>
- <https://www.youtube.com/watch?v=5Z-pHEJuL-U>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Problem-Based Learning (PBL)
- Simulation and Virtual Labs
- ICT-Enabled Teaching

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

- A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.
- In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include a **maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Multimeter-based electrical testing and fault finding for shipboard electrical circuits.	15
2.	Basic wiring activity for a low-voltage lighting/control circuit.	10

Continuous Internal Evaluation (CIE)

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

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1 Multimeter-based electrical testing and fault finding for shipboard electrical circuits.					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Safe use of multimeter and range selection	Selects correct function/range, probes and safety method independently.	Minor prompting needed; safe method followed.	Basic selection correct with some hesitation.	Incorrect selection or unsafe handling corrected by teacher.	Unable to select/use meter safely.
Measurement and testing skill	Accurately measures voltage, resistance, continuity and polarity; records readings clearly.	Mostly accurate measurements with minor errors.	Completes basic measurements with some errors.	Incomplete or inconsistent measurement process.	Unable to perform required measurements.
Fault identification and reasoning	Correctly identifies open/short/loose-connection faults and explains cause.	Identifies faults with minor reasoning gaps.	Identifies simple faults with support.	Weak diagnosis; mostly guessing.	Unable to identify faults.
Interpretation and shipboard relevance	Links readings to marine electrical maintenance and safety practice clearly.	Good interpretation with minor omissions.	Basic interpretation given.	Limited relevance to maintenance practice.	No meaningful interpretation.
Teamwork, observation record and oral explanation	Active teamwork, complete record and clear oral explanation.	Good participation and mostly complete record.	Adequate participation/record.	Poor participation or incomplete record.	No record or participation.

Rubrics for Learning Activity 2 Basic wiring activity for a low-voltage lighting/control circuit.					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Wiring diagram and component selection	Clear circuit diagram and correct selection of switch, fuse/MCB, lamp/load and terminals.	Mostly correct diagram/component choice.	Basic diagram with minor omissions.	Incomplete diagram or unsuitable components.	No usable diagram/component selection.
Wiring correctness	Circuit wired correctly with proper	Minor wiring errors corrected	Functional wiring with	Several errors; circuit works	Unable to complete wiring.

	connections and terminal discipline.	independently.	teacher support.	only after correction.	
Safety, insulation and neatness	Neat wiring with safe isolation, insulation awareness and secure connections.	Mostly safe and neat with minor issues.	Acceptable safety and neatness.	Poor neatness or safety gaps.	Unsafe work practice.
Testing and troubleshooting before energizing	Performs continuity/polarity checks and troubleshoots systematically using multimeter.	Testing mostly complete with minor omissions.	Basic testing completed with support.	Limited testing; misses important checks.	No testing before energizing.
Team coordination and activity record	Effective team coordination and complete activity record.	Good coordination and mostly complete record.	Adequate coordination/record.	Poor coordination or incomplete record.	No record or coordination.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Multimeter-based electrical testing and fault finding for shipboard electrical circuits.	14
2.	Basic wiring activity for a low-voltage lighting/control circuit.	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	MOOCs/NPTEL Courses	12
2.	Video Lectures / Virtual Lab	12

Mechanical Measurements and Metrology Lab			
Course Code	1BMEL405	Scheme	2025
Type of Course	PCCL	Semester	IV
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	Practical	Exam Hours	2
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Explain the principles of measurement and metrology and recognize the importance of precision, accuracy, calibration, and standards in engineering applications. 2. Use conventional measuring instruments effectively, such as vernier calipers, micrometers, slip gauges, bevel protractors, comparators, and gauges for dimensional inspection. 3. Perform linear, angular, and comparative measurements of engineering components and interpret the results with reference to tolerances, limits, and fits. 4. Analyse measurement errors and assess instrument performance by identifying sources of uncertainty, repeatability, and calibration deviations in practical measurements. 5. Apply metrology concepts to open-ended engineering problems, including inspection planning, calibration studies, reverse engineering, and quality evaluation of manufactured parts.			
PART – A			
FIXED SET OF EXPERIMENTS			
1. Introduction to Metrology and Basic Linear Measurements • Measurement using Vernier Caliper, Micrometer, Vernier Height Gauge, and Vernier Depth Gauge. 2. Measurement of Angles • Taper angle measurement using Sine Bar/Sine Centre and Slip Gauges. 3. Angular Measurement using Universal Bevel Protractor 4. Calibration of Outside Micrometer using Slip Gauges as Standard 5. Calibration of LVDT for Linear Displacement Measurement 6. Calibration of Load Cell for Force Measurement 7. Calibration of Thermocouple for Temperature Measurement 8. Inspection of Circular Run-out using Dial Indicator 9. Measurement of Surface Roughness using Surface Roughness Tester 10. Determination of the Effective Diameter of a Metric Thread using the Three-Wire Method			
PART – B			
OPEN ENDED EXPERIMENTS			
Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.			
1. Selection of suitable measuring instruments for dimensional and geometrical inspection of a given engineering component. 2. Calibration and performance assessment of a measuring instrument or sensor. 3. Evaluation of Surface Roughness of Engineering Components Manufactured by Different Machining Processes.			
Suggested Learning Resources:			
Textbooks:			
1. Beckwith Marangoni and Lienhard, “Mechanical Measurements” 6th Ed., Pearson Education, 2007. 2. R K Jain, “Engineering Metrology”, 22nd Ed., Khanna Publishers, 2011.			
Reference books / Manuals:			
1. I C Gupta, “Engineering Metrology”, 7th Ed., Dhanpat Rai Publications, Delhi, 2012. 2. Graham T Smith, “Industrial Metrology”, 3rd Ed., Springer Publications, USA.			

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/112104250>
- <https://nptel.ac.in/courses/112106179>

Teaching-Learning Process (Innovative Delivery Methods):

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

- ICT-Enabled Teaching
- Adopt collaborative (Group Learning) learning in the class.
- Demonstrations

Assessment Structure:

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

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

For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

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

Rubrics for CIE – Continuous assessment:					
Performance Indicator (COs/POs)	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Understanding of Metrology Concepts and Measurement Techniques (P01)	Clearly explains the principles, operating procedures, and applications of measuring instruments and calibration techniques using appropriate technical terminology.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding of measurement concepts and instrument operation.	Demonstrates limited understanding with several inaccuracies.	Unable to explain the concepts or operation of measuring instruments.
Observation and Interpretation (P02)	Accurately records measurements and observations, analyses the results, estimates measurement errors (where applicable), and relates the findings to the objectives of the experiment.	Records observations correctly with minor omissions in analysis or interpretation.	Records basic observations with limited analysis or interpretation.	Observations are incomplete or inaccurate with poor interpretation.	Fails to record meaningful observations or interpret the results.
Documentation (P09)	Laboratory record is complete, well-organized, and includes objectives, instrument details, procedure, observations, calculations, graphs/tables (where applicable), results, and conclusions for all experiments.	Laboratory record is complete with minor omissions or formatting issues.	Laboratory record contains most essential sections with acceptable organization.	Laboratory record is incomplete or poorly organized with several missing sections.	Laboratory record is inadequate or not submitted.
Use of Figures, Sketches and Technical Presentation (P09)	Includes clear sketches, instrument layouts, calibration curves / graphs, tables, and neat technical presentation that effectively supports the report.	Includes appropriate sketches, figures, or tables with minor presentation issues.	Includes basic sketches/tables with acceptable presentation.	Limited or poorly presented sketches, figures, or tables.	No relevant sketches, figures, graphs, or tables included.

Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (P01)	Clearly understands the measurement/inspection or calibration problem independently and identifies the appropriate measuring instrument and procedure.	Understands the problem with minor clarifications.	Demonstrates partial understanding and requires guidance.	Misinterprets the problem or selects an inappropriate measurement method.	Unable to understand the problem or identify the required measuring instrument.
Measurement / Inspection Approach (P02)	Selects the appropriate measuring instrument, follows the correct measurement/calibration procedure, and applies the method systematically.	Selects the correct method with minor procedural errors.	Uses the basic measurement method with occasional guidance.	Incorrect selection of instrument or procedure; requires frequent assistance.	Unable to select or apply an appropriate measurement/calibration method.
Execution of Measurement / Calibration (P03, P05)	Performs measurement/calibration accurately, handles instruments properly, follows standard procedures and safety practices, and records observations systematically.	Performs the experiment correctly with minor execution or observation errors.	Performs the experiment satisfactorily with acceptable measurements and observations.	Frequent errors in instrument handling, measurement technique, or recording of observations.	Unable to perform the experiment or demonstrates inadequate understanding of the measuring instrument.
Results, Accuracy and Interpretation (P04)	Obtains accurate results, validates measurements through appropriate calculations/comparisons, estimates errors (where applicable), and draws correct conclusions.	Results are generally accurate with minor deviations and acceptable interpretation.	Results are partially correct with limited analysis or interpretation.	Results are inaccurate with weak or incorrect interpretation.	Unable to obtain meaningful results or interpret the observations.
Viva-Voce (P09)	Answers confidently with thorough understanding of metrology principles, measuring instruments, calibration methods, and applications.	Demonstrates good understanding with minor conceptual gaps.	Provides basic answers with acceptable understanding.	Gives limited responses and requires prompting.	Unable to answer questions satisfactorily.

Machine Learning using Python			
Course Code	1BMEL406A	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L : T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L : T : P : SL : TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Explain the basic concepts of Machine Learning. 2. Use Python for simple data analysis tasks. 3. Perform data preprocessing using Python libraries. 4. Visualize data using basic plotting tools. 5. Develop simple machine learning models and evaluate their performance.			
SET OF EXPERIMENTS			
1. Introduction to Python programming – variables, operators, input/output, and basic functions. 2. Working with NumPy arrays and basic mathematical operations. 3. Introduction to Pandas – creating and manipulating data frames. 4. Reading and analyzing datasets using Pandas. 5. Handling missing values and basic data preprocessing. 6. Data visualization using Matplotlib (bar chart, line chart, pie chart, and histogram). 7. Introduction to Machine Learning and Scikit-Learn library. 8. Dataset splitting into training and testing sets. 9. Simple Linear Regression for prediction. 10. Classification using K-Nearest Neighbors (KNN). 11. Evaluating model performance using accuracy score and confusion matrix. 12. Mini-project: Build a simple prediction model using a small real-world dataset.			
Suggested Learning Resources: Textbooks: 1. Jake VanderPlas, “Python Data Science Handbook”, 2nd Ed., O'Reilly, 2016. 2. Andreas C Müller and Sarah Guido, “Introduction to Machine Learning with Python”, O'Reilly, 2016 3. Wes McKinney, “Python for Data Analysis”, 3rd Ed., O'Reilly, 2022. Reference books / Manuals: 1. Ethem Alpaydin, “Introduction to Machine Learning”, 4th Ed., MIT Press, 2014. 2. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, 2017. 3. Scikit-Learn User Documentation.			
Web links and Video Lectures (e-Resources): ➤ https://nptel.ac.in/courses/106106182 ➤ https://nptel.ac.in/courses/106106212			
Teaching-Learning Process (Innovative Delivery Methods): The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes. 1. Demonstration-based laboratory sessions. 2. Hands-on coding exercises using Jupyter Notebook or Google Colab. 3. Learning through real-life datasets. 4. Peer discussions and collaborative problem-solving. 5. Mini-project-based learning.			

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Concept Understanding & Python Programming (P01)	Demonstrates comprehensive understanding of Python programming concepts, data structures, libraries, and their applications in data analysis and machine learning.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding with limited application.	Demonstrates partial understanding with incorrect application.	Demonstrates little or no understanding of Python programming concepts.
Program Development and Implementation (P02, P03)	Develops well-structured, efficient, and error-free Python programs using appropriate libraries to solve the assigned problem.	Develops correct programs with minor logical or syntax errors.	Develops basic programs with limited functionality or efficiency.	Develops incomplete programs requiring significant corrections.	Unable to develop a functional program.
Data Analysis and Machine Learning Implementation (P03, P04)	Effectively applies data preprocessing, visualization, and machine learning techniques to analyse datasets and obtain meaningful results.	Correctly applies the required techniques with minor refinements needed.	Performs basic data analysis or machine learning with limited interpretation.	Requires significant guidance to complete data analysis or model development.	Unable to perform data analysis or implement machine learning techniques.
Analysis and Interpretation of Results (P04)	Critically analyses program outputs, validates results using appropriate evaluation metrics, and provides meaningful interpretation and conclusions.	Correctly interprets results with minor omissions.	Provides basic interpretation with limited validation.	Interpretation is weak or partially incorrect.	Unable to analyse or interpret the program results.
Laboratory Record, Program Documentation & Presentation (P09, P010)	Laboratory record is complete, well-organized, and includes objectives, algorithms, source code, outputs, observations, analysis, conclusions, and proper documentation.	Record is complete with minor omissions or presentation issues.	Record contains essential information but lacks clarity or detail.	Record is incomplete, poorly organized, or lacks proper documentation.	Record is inadequate or not submitted.

Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (PO1)	Clearly understands the programming or machine learning problem and independently identifies the appropriate Python libraries, algorithms, and solution approach.	Understands the problem with minor clarifications.	Demonstrates basic understanding but requires guidance.	Partially understands or misinterprets the problem.	Unable to understand the problem.
Program Design and Solution Strategy (PO2, PO3)	Develops a well-structured program and selects the most appropriate Python constructs, libraries, and machine learning techniques to solve the assigned problem efficiently.	Develops an appropriate program with minor deficiencies in logic or implementation.	Develops a basic program that partially solves the problem.	Develops an incomplete or inefficient program requiring significant guidance.	Unable to develop a meaningful program or solution strategy.
Program Implementation and Tool Utilization (PO3, PO5)	Correctly implements the program using Python and relevant libraries (NumPy, Pandas, Matplotlib, Scikit-Learn), executes it successfully, and effectively utilizes the required tools.	Implements the program correctly with minor coding or execution errors.	Implements a basic program with limited functionality or minor execution issues.	Implements the program with frequent coding or execution errors.	Unable to implement or execute the program successfully.
Output Analysis and Interpretation (PO4)	Critically analyses the program output, validates results using appropriate evaluation methods or performance metrics, and provides meaningful conclusions.	Correctly interprets the output with minor omissions or inaccuracies.	Provides basic interpretation with limited validation of results.	Interpretation is incomplete or technically weak.	Unable to analyse or interpret the program output.
Viva-Voce (PO9)	Answers confidently with comprehensive understanding of Python programming, data analysis, machine learning concepts, algorithms, libraries, and applications.	Demonstrates good understanding with minor conceptual gaps.	Provides basic answers with acceptable understanding.	Responds with limited understanding and requires prompting.	Unable to answer questions satisfactorily.

PLC and Automation			
Course Code	1BMEL406B	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L : T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L : T : P : SL : TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Explain the fundamentals of Programmable Logic Controllers (PLCs) and industrial automation. 2. Identify basic PLC hardware components and their functions. 3. Develop simple ladder logic programs for industrial control applications. 4. Interface input and output devices with PLCs. 5. Design and implement basic automation systems using PLC programming.			
SET OF EXPERIMENTS 1. Familiarization with PLC hardware, software, and programming environment. 2. Study of PLC architecture, input/output modules, and wiring concepts. 3. Development of basic ladder logic programs using logic gates (AND, OR, NOT). 4. Implementation of start-stop control of a motor using PLC. 5. Design of timer-based control circuits using ON-delay and OFF-delay timers. 6. Development of counter-based applications using PLC counters. 7. Control of traffic light sequencing using ladder logic. 8. Automatic water tank level monitoring and pump control using PLC. 9. Sequential control of industrial processes using PLC. 10. Interfacing sensors and actuators with PLC systems. 11. Introduction to Human Machine Interface (HMI) and monitoring of PLC operations. 12. Mini-project: Design and implementation of a simple industrial automation application using PLC.			
Suggested Learning Resources: Textbooks: 1. Frank D Petruzella, "Programmable Logic Controllers", 5th Ed., McGraw-Hill, 2023. 2. John W Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Ed., Pearson, 2002. Reference books / Manuals: 1. Gary Dunning, "Introduction to Programmable Logic Controllers", 3rd Ed., Delmar Pub, 2006. 2. W Bolton, "Programmable Logic Controllers", Newnes, 6th Ed., 2015. 3. PLC Programming Manuals of Siemens. 4. PLC Programming Manuals of Allen-Bradley. 5. PLC Programming Manuals of Delta PLCs.			
Web links and Video Lectures (e-Resources): ➤ https://nptel.ac.in/courses/108105088 ➤ https://www.youtube.com/watch?v=jzy0so3h_kc ➤ https://www.youtube.com/@PLCGurusNET ➤ https://www.youtube.com/@realpars			
Teaching-Learning Process (Innovative Delivery Methods): The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes. 1. Demonstration of PLC hardware and industrial automation setups. 2. Hands-on programming using PLC simulation software. 3. Problem-based learning through industrial case studies. 4. Group activities for ladder logic development and troubleshooting. 5. Mini-project-based learning involving real-world automation applications.			

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Concept Understanding & PLC Application (P01)	Demonstrates comprehensive understanding of PLC architecture, programming concepts, industrial automation, and the application of PLCs in control systems.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding with limited application.	Demonstrates partial understanding with incorrect application.	Demonstrates little or no understanding of PLC concepts.
PLC Program Development and Implementation (P02, P03)	Develops well-structured ladder logic programs, correctly configures inputs/outputs, timers, counters, and control logic to achieve the desired automation task.	Develops effective PLC programs with minor logical or implementation errors.	Develops basic PLC programs with limited functionality.	Develops incomplete or incorrect PLC programs requiring significant guidance.	Unable to develop a functional PLC program.
Automation System Design and Troubleshooting (P03, P04)	Effectively designs, implements, tests, and troubleshoots PLC-based automation systems by correctly interfacing sensors, actuators, and HMI components.	Successfully implements automation tasks with minor troubleshooting or configuration issues.	Implements basic automation applications with limited troubleshooting ability.	Requires significant guidance in system implementation and troubleshooting.	Unable to implement or troubleshoot PLC-based automation tasks.
Analysis and Interpretation of PLC Operation (P04)	Critically analyses PLC program execution, interprets input/output status, timing sequences, system response, and validates the correctness of the automation process.	Correctly interprets PLC operation with minor omissions.	Provides basic interpretation with limited validation of results.	Interpretation is weak or partially incorrect.	Unable to analyse or interpret PLC operation.

Laboratory Record, Program Documentation & Presentation (P09, P010)	Laboratory record is complete, well-organized, and includes objectives, ladder diagrams, wiring diagrams, program listings, observations, results, troubleshooting details, and conclusions with proper documentation.	Record is complete with minor omissions or presentation issues.	Record contains essential information but lacks clarity or detail.	Record is incomplete, poorly organized, or lacks proper documentation.	Record is inadequate or not submitted.
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Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (P01)	Clearly understands the automation problem and independently identifies the appropriate PLC hardware, I/O configuration, and control strategy.	Understands the problem with minor clarifications.	Demonstrates basic understanding but requires guidance.	Partially understands or misinterprets the automation problem.	Unable to understand the problem or identify the required PLC application.
PLC Program Design and Solution Strategy (P02, P03)	Develops a well-structured ladder logic program and selects appropriate PLC instructions, timers, counters, I/O modules, and control logic to accomplish the assigned automation task.	Develops an appropriate PLC program with minor deficiencies in logic or implementation.	Develops a basic PLC program that partially satisfies the required automation task.	Develops an incomplete or ineffective PLC program requiring significant guidance.	Unable to develop a meaningful PLC program or solution strategy.
Program Execution and PLC System Implementation (P03, P05)	Correctly configures the PLC system, executes the ladder program, interfaces inputs/outputs, sensors, actuators, or HMI (where applicable), and verifies proper operation of the automation system.	Executes the PLC program correctly with minor configuration or implementation errors.	Executes a basic PLC program with limited functionality or minor operational issues.	Executes the program with frequent errors in configuration or operation.	Unable to execute the PLC program or implement the assigned automation task.
Output Analysis and Automation System Interpretation (P04)	Critically analyses PLC operation, validates input/output responses, timing sequences, and	Correctly interprets PLC outputs with minor omissions or inaccuracies.	Provides basic interpretation with limited validation of system performance.	Interpretation is incomplete or technically weak.	Unable to analyse or interpret PLC operation or

	control logic, and provides appropriate engineering conclusions.				automation results.
Viva-Voce (P09)	Answers confidently with comprehensive understanding of PLC architecture, ladder logic programming, industrial automation, sensors, actuators, HMI, and troubleshooting techniques.	Demonstrates good understanding with minor conceptual gaps.	Provides basic answers with acceptable understanding.	Responds with limited understanding and requires prompting.	Unable to answer questions satisfactorily.

Simulation of Kinematic Systems			
Course Code	1BMEL406C	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L : T : P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L : T : P : SL : TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to: 1. Create and simulate kinematic models using commercial multibody dynamics software. 2. Apply kinematic constraints, joints, and motion drivers to model engineering mechanisms. 3. Analyze displacement, velocity, and acceleration characteristics of planar and spatial mechanisms. 4. Interpret simulation results and validate the kinematic behavior of mechanical systems. 5. Evaluate the performance of common engineering mechanisms such as linkages, cams, gears, and robotic systems. 6. Utilize simulation tools for the design and analysis of practical mechanical engineering systems.			
SET OF EXPERIMENTS			
1. Introduction to Kinematic Simulation Software and Mechanism Modelling 2. Simulation of a Four-Bar Linkage Mechanism 3. Position Analysis of a Slider-Crank Mechanism 4. Velocity Analysis of a Slider-Crank Mechanism 5. Acceleration Analysis of a Slider-Crank Mechanism 6. Simulation of Quick Return Mechanism 7. Simulation of Whitworth Quick Return Mechanism 8. Simulation of Cam and Follower Mechanism 9. Simulation of Gear Pair Mechanism 10. Simulation of Geneva Mechanism 11. Simulation of Differential Mechanism 12. Kinematic Analysis of an Industrial Robotic Manipulator Note: Students may perform the experiments using any one of the following commercial software packages: MSC Adams /SolidWorks Motion /Autodesk Inventor Dynamic Simulation /Siemens NX Motion /CATIA Kinematics or any other equivalent free or open-source software.			
Suggested Learning Resources:			
<u>Textbooks</u>			
1. Rattan S S, "Theory of Machines", 5th Ed., McGraw Hill Education, 2022. 2. Uicker J J, Pennock G R, and Shigley J E, "Theory of Machines and Mechanisms", 4th Ed., Oxford University Press, 2017. 3. Thomas Bevan, "Theory of Machines", 3rd Ed., CBS Publishers, 2019.			
<u>Reference Books / Manuals</u>			
1. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanisms and Machines", 3rd Ed., East-West Press, 2019. 2. Robert L Norton, "Design of Machinery", 6th Ed., McGraw Hill Education, 2020. 3. MSC Adams User Manual. 4. SolidWorks Motion Analysis User Guide.			

Web Links and Video Lectures (e-Resources)

Software Learning Resources

1. MSC Adams Documentation and Tutorials
<https://hexagon.com/products/adams>
2. MSC Adams Learning Resources
<https://simcompanion.hexagon.com>
3. SolidWorks Motion Analysis Tutorials
<https://help.solidworks.com>
4. Autodesk Inventor Dynamic Simulation Tutorials
<https://help.autodesk.com/view/INVNTOR>
5. Siemens NX Motion Simulation Resources
<https://docs.sw.siemens.com>
6. CATIA Kinematics Documentation
<https://www.3ds.com/products-services/catia>

Theory of Machines and Kinematics Resources

1. NPTEL – Theory of Machines
<https://nptel.ac.in/courses>
2. SWAYAM Portal
<https://swayam.gov.in>
3. MIT OpenCourseWare – Mechanical Engineering Courses
<https://ocw.mit.edu>
4. Mechanical Engineering Video Lectures (NPTEL)
<https://www.youtube.com/@nptelhrd>

Video Lecture Resources

1. SolidWorks YouTube Channel
<https://www.youtube.com/@solidworks>
2. Autodesk Inventor YouTube Channel
<https://www.youtube.com/@Autodesk>
3. Siemens Software YouTube Channel
<https://www.youtube.com/@SiemensSoftware>
4. CATIA Official Channel
<https://www.youtube.com/@3DEXPERIENCEWorks>
5. MIT OpenCourseWare YouTube Channel
<https://www.youtube.com/@mitocw>

Additional Learning Resources

1. Khan Academy – Differential Equations and Mechanical Motion
<https://www.khanacademy.org/math/differential-equations>
2. Engineering LibreTexts – Kinematics and Dynamics
<https://eng.libretexts.org>
3. Wolfram Demonstrations Project – Mechanism Simulations
<https://demonstrations.wolfram.com>

Recommended e-Resources for Course Delivery

- MSC Adams Tutorials and Documentation
- SolidWorks Motion Analysis Tutorials
- NPTEL Theory of Machines Courses
- MIT OpenCourseWare Resources
- Siemens NX Motion Tutorials
- Autodesk Inventor Dynamic Simulation Tutorials
- Official YouTube Channels of MSC Adams, SolidWorks, Autodesk, and Siemens

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Demonstration and Guided Simulation
2. Hands-on Software-Based Learning
3. Visualization-Based Learning
4. Problem-Based Learning
5. Mini-Project and Case Study Approach

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Mechanism Modeling and Constraint Definition (C01, C02)	Accurately models mechanisms such as four-bar linkages, slider-crank, cam-follower, gears, and robotic manipulators with correct joints and constraints independently.	Models mechanisms correctly with minor errors in constraints or assembly.	Models basic mechanisms but requires guidance to define constraints correctly.	Creates incomplete models and requires significant assistance.	Unable to create a functional mechanism model.
Motion Simulation and Kinematic Analysis (C02, C03)	Successfully performs simulations and accurately obtains displacement, velocity, acceleration, trajectories, and motion characteristics.	Performs simulations correctly with minor errors in result extraction or analysis.	Performs basic simulations and obtains limited kinematic results.	Requires substantial assistance to perform simulations and interpret outputs.	Unable to perform simulations or generate meaningful results.
Analysis of Engineering Mechanisms (C03, C04, C05)	Accurately analyzes the performance of mechanisms such as quick-return, Geneva, cam-follower, gear trains, and robotic manipulators, and clearly explains their kinematic behavior.	Demonstrates good understanding with minor interpretation errors.	Demonstrates basic understanding of mechanism operation and motion characteristics.	Shows limited understanding of mechanism behavior and simulation results.	Unable to explain mechanism operation or simulation outcomes.
Documentation, Demonstration	Maintains complete laboratory records,	Maintains good records	Maintains satisfactory	Records are	Fails to maintain

and Software Proficiency (C01, C06)	presents simulation studies effectively, and demonstrates excellent proficiency in commercial simulation software.	and demonstrates software usage with minor errors.	records and demonstrates basic software skills.	incomplete and software usage requires significant guidance.	records or demonstrates software proficiency.
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Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Mechanism Modeling and Simulation Setup (C01, C02)	Accurately creates mechanism models, applies joints, constraints, and motion drivers, and performs simulations independently without errors.	Creates and simulates mechanisms with minor errors requiring little guidance.	Creates basic mechanism models with some errors in setup or constraints.	Requires significant assistance to model and simulate mechanisms.	Unable to create a valid mechanism model or perform simulation.
Kinematic Analysis and Result Generation (C02, C03)	Accurately generates and evaluates displacement, velocity, acceleration, and trajectory results for the given mechanism.	Generates correct results with minor errors in analysis or interpretation.	Obtains basic simulation results but analysis is limited.	Generates incomplete or partially incorrect results.	Unable to generate meaningful kinematic results.
Interpretation of Mechanism Behavior (C03, C04, C05)	Clearly explains mechanism motion, identifies key kinematic characteristics, and relates results to engineering applications.	Demonstrates good understanding with minor interpretation errors.	Demonstrates basic understanding of mechanism operation and motion characteristics.	Shows limited understanding of simulation results and mechanism behavior.	Unable to explain mechanism behavior or simulation outcomes.
Viva Voce and Software Proficiency (C01, C06)	Confidently answers questions related to mechanism modeling, simulation procedures, and result interpretation; demonstrates excellent software proficiency.	Answers most questions correctly and demonstrates good software skills.	Answers basic questions satisfactorily and demonstrates adequate software usage.	Answers few questions correctly and requires prompting to demonstrate software operations.	Unable to answer questions or demonstrate software usage.

Surface Modelling			
Course Code	1BMEL406D	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L:T:P)	0:0:2	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	0:0:28:2:0	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	2
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Explain the concepts of geometric representation and surface modelling. 2. Create basic and advanced surface features using CAD software. 3. Apply surface modelling techniques for product development and styling.			
SET OF EXPERIMENTS			
PART A (3 SESSIONS: 6 Hours): 40 Marks			
Module 1: Introduction to Surface Modelling • Geometric modelling: Wireframe, Surface, and Solid modelling • Applications of surface modelling in engineering • Parametric and non-parametric modelling • Overview of CAD software for surface modelling • Generation of various types of curves • Surface generation techniques by using Extrude, Revolve, Sweep, Loft, Boundary surfaces etc – Surface modeling of simple 4 components.			
PART B (10 SESSIONS: 20 Hours): 60 Marks			
Advanced Surface Modelling techniques using Trimming and extending surfaces, Surface blending and filleting, Surface offsetting and thickening and such of those commands / techniques used to “Develop aesthetic and functional surfaces”.			
Create a Surface modelling of the following components: • Liquid container to carry a specific volume of Shampoo/Cooking oil. • Cover of a hair-dryer for the given dimensions. • Computer mouse for the given dimensions. • Car bumper • Motorcycle fuel tank • Drone body shell • Surface Modelling for Automotive/Aeronautical applications			
Suggested Learning Resources:			
Textbooks: 1. Michael E. Mortenson, “Geometric Modeling”, 3rd Ed., Industrial Press, 2006. 2. Ibrahim Zeid, “CAD/CAM Theory and Practice”, 2nd Ed., McGraw-Hill Education, 2009.			
Reference books / Manuals: 1. Les Piegl and Wayne Tiller, “The NURBS Book”, Springer-Verlag, 1997. 2. Gerald Farin, “Curves and Surfaces for Computer-Aided Geometric Design: A Practical Guide”, Academic Press, 2002.			
Web links and Video Lectures (e-Resources): • https://nptel.ac.in/courses/112102102 • https://www.youtube.com/watch?v=4G2E_DqQteM			

Teaching-Learning Process (Innovative Delivery Methods):

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

1. Flipped classrooms
2. Reverse Engineering activities
3. Industry Case-Based Learning
4. Mini design challenges

Assessment Structure:

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

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

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

Rubrics for CIE – Continuous assessment:

Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Concept Understanding of Surface Modelling (P01)	Demonstrates comprehensive understanding of wireframe, surface, and solid modelling, surface generation techniques, and their engineering applications.	Demonstrates good understanding with minor conceptual gaps.	Demonstrates basic understanding with limited application of concepts.	Demonstrates partial understanding with incorrect application of surface modelling concepts.	Demonstrates little or no understanding of surface modelling concepts.
CAD Modelling Skills and Command Application (P02, P03)	Effectively applies CAD tools and commands such as Extrude, Revolve, Sweep, Loft, Boundary, Trim, Extend, Blend, Fillet, Offset, and Thicken to develop accurate and high-quality surface models.	Applies most CAD commands correctly with minor errors or refinements required.	Applies basic CAD commands with partially correct models requiring improvements.	Uses CAD commands with significant errors and requires continuous guidance.	Unable to apply appropriate CAD commands to create surface models.
Surface Design, Accuracy and Engineering Application (P03, P04)	Develops aesthetically pleasing and functionally accurate surface models that satisfy design intent, dimensions, continuity, and engineering requirements.	Develops accurate models with minor dimensional or surface quality deviations.	Develops acceptable models with noticeable inaccuracies in geometry or continuity.	Models are incomplete or exhibit major dimensional and geometric errors.	Unable to develop functional surface models meeting design requirements.

Laboratory Record, Model Documentation & Presentation (P09, P010)	Laboratory record is complete, well-organized, and includes modelling procedure, command sequence, screenshots, observations, dimensions, design rationale, conclusions, and proper documentation.	Record is complete with minor omissions or presentation issues.	Record contains essential information but lacks clarity, screenshots, or sufficient detail.	Record is incomplete, poorly organized, or lacks proper documentation.	Record is inadequate or not submitted.
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Rubrics for SEE / CIE Test:					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Problem Understanding (P01)	Clearly understands the design problem, interprets the given dimensions/specifications accurately, and identifies the appropriate surface modelling approach independently.	Understands the design problem with minor clarifications required.	Demonstrates basic understanding but requires guidance to interpret specifications.	Partially understands or misinterprets the design requirements.	Unable to understand the modelling problem or design requirements.
Surface Modelling Strategy and CAD Command Application (P02, P03)	Selects and effectively applies appropriate surface modelling techniques and CAD commands (Extrude, Revolve, Sweep, Loft, Boundary, Trim, Extend, Blend, Fillet, Offset, Thicken, etc.) to develop accurate and aesthetically pleasing models.	Applies appropriate modelling techniques with minor errors or refinements required.	Uses basic modelling commands to develop partially correct surface models.	Uses modelling commands with significant errors and requires continuous guidance.	Unable to select or apply appropriate CAD commands for surface modelling.
Surface Model Development and Engineering Application (P03, P05)	Develops complete, dimensionally accurate, functional, and aesthetically optimized surface models that satisfy engineering requirements and design intent.	Develops accurate surface models with minor dimensional or geometric deviations.	Develops acceptable models with limited accuracy or surface continuity.	Produces incomplete models with major geometric or dimensional errors.	Unable to develop a functional surface model meeting the specified requirements.
Model Evaluation and Engineering Interpretation (P04)	Critically evaluates surface quality, continuity, and manufacturability, and functionality; identifies modelling limitations and proposes appropriate improvements with sound engineering justification.	Correctly evaluates the model with minor omissions or inaccuracies.	Provides basic evaluation with limited validation of model quality.	Evaluation is incomplete or technically weak and requires guidance.	Unable to analyse or evaluate the developed surface model.
Viva-Voce (P09)	Answers confidently with comprehensive understanding of surface modelling concepts, CAD commands, modelling strategies, engineering applications, and design considerations.	Demonstrates good understanding with minor conceptual gaps.	Provides basic answers with acceptable understanding of modelling concepts and commands.	Responds with limited understanding and requires frequent prompting.	Unable to answer questions satisfactorily.

Basic Ship Knowledge and Watchkeeping			
Course Code	1BMR409	Scheme	2025
Type of Course	PCC	Semester	IV
Teaching Hours/Week (L:T:P)	3:0:0	CIE Marks	50
Total Hours of Pedagogy per semester L:T:P:SL:TW	42:0:0:30:18	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3
Course outcome (Course Skill Set)			
At the end of the course, the student will be able to:			
1. Describe parts of a ship, types of vessels and watchkeeping routines 2. Illustrate the ship structure, vessel types, shipboard ranks, voyages, and emergency procedures. 3. Explain deck and engine room arrangements, ship operations, manning, COC and emergencies 4. Identify ship layouts, vessel types; requirements of competence and apply principles of seamanship to specific emergency scenarios.			
Module-1			
Introduction to ship layout			
Introduction to ship layout; longitudinal view and midship section; parts of a ship including hull, deck, bottom, double bottom, bulkheads (collision and aft), cargo holds, forecastle and poop decks, deck houses and accommodation; propulsion and shafting system including main engine, intermediate shaft, propeller shaft, stern tube with seals, propeller and stern cooling arrangement; tanks and spaces including double bottom tanks, fore peak tank, aft peak tank, cofferdam and chain locker; steering system including rudder and rudder stock; deck arrangements including air vents, sounding pipes, ventilators, bunker manifold, masts, CO ₂ room and paint store; accommodation spaces including bridge, galley, mess rooms, cargo control room and stores; engine room auxiliaries including generator engines and cold storage rooms (meat, vegetable and dry provision rooms); deck machinery including mooring winches, windlass and anchor chain.			
			Number of Hours: 9
Module-2			
Types of ships and its operations			
Unit Cargo – Container vessel, RORO, Refrigerated ships, cattle ship and heavy cargo ship. Bulk Cargo – Bulk carrier, ore carrier, Coal carrier and Grain carrier. Liquid cargo- Crude carrier - product tanker , Chemical tanker, LPG Tanker and LNG tanker. Offshore vessels – Drillships, Anchor handling Tugs, Platform supply vessels, Accommodation vessels. Dredgers, Port vessels - Tugs and Pilot vessels. Operation of ocean going vessels – difference between coastal ships and foreign going ships, difference between short and unrestricted international voyages. Arrival and departure procedures for ships with familiarization of various notices and action to be taken in case of emergencies.			
			Number of Hours: 9
Module-3			
Manning of ships, Certificate of competence			
Manning - Deck, Engine and catering depts., officers and crew. Safe manning of a vessel. Certificate of competence, Requirements of COC- Class IV, Class II and Class I as per DG shipping, Introduction to DG and MMD and their roles- Flag state and port state control / inspection, Reasons for detention of vessels Introduction to IMO, STCW and its role – (only Chapter III), pre sea courses, Post Sea courses, specialized vessels courses.			
			Number of Hours: 8
Module-4			
Operation of Vessel and Watchkeeping			
Vessel operations in port for loading, unloading or both, including draft marks, trim, heel, loading limits and load line marks on the ship's side; anchorage, pilotage and berthing of vessels; definition and principles of watchkeeping, watch arrangements including sea watch, port watch and anchor watch, and duties of the engineer officer at sea and in port; requirements of watchkeeping including fitness for duty, rest hours, alcohol limits and Certificate of Competency (CoC), along with maintenance of engine room log book and movement book, and distinction between ship's log book and engine room log book; preparation of main diesel engine for sea voyage, bow and stern thrusters, and essential systems			

required for operation of the main engine; dry docking including purpose of dry docking and floating dry dock.

Number of Hours: 8

Module-5

Shipboard Emergencies

Fire -Fire Triangle , Types of Fire , Fire in Engine room, Portable extinguishers and types, Fixed fire fighting systems, Fire main system including emergency fire pump system , Hoses and Hydrants . Cargo hold fire, Paint store fire, accommodation fire, Galley exhausts fire and deep fat fryer fire.

Towing arrangement in ships.

Grounding – To check tank soundings, precautions, Towing of a vessel after grounding. Collision

Flooding of engine room – emergency bilge suction

Power failure – Emergency Generator.

Introduction to SOLAS and SOLAS lifeboats, life rafts

Man overboard

Number of Hours: 8

Suggested Learning Resources:

Textbooks:

1. J K Dhar, "Basic Marine Engineering", 12th Ed., G-Maritime Publications, 2023.
2. David J House, "Seamanship Techniques: Shipboard and Marine Operations", 5th Ed., Routledge, 2018.

Reference books / Manuals:

1. Paul A Russell, Leslie Jackson and Thomas D Morton, "General Engineering Knowledge for Marine Engineers", Reeds Vol. 8, 6th Ed., Bloomsbury, 2018.
2. "SOLAS Consolidated Edition 2024", International Maritime Organization; 2024.
3. "MARPOL Consolidated Edition 2022", International Maritime Organization; 2022

Web links and Video Lectures (e-Resources):

- <https://www.imo.org/en/knowledgecentre/conferencesmeetings/pages/solas.aspx>
- <https://www.dieselduck.info/index.html>
- <https://www.youtube.com/watch?v=Q7Espb0afMw>

Teaching-Learning Process (Innovative Delivery Methods):

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

- Flipped Classroom
- Interactive Chalk-and-Talk
- Software-Aided Mechanism Simulation:
- Project-Based Fabrication Tasks:
- Case-Studies

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks, i.e., 20 marks.**
- To pass the **SEE**, a student must score at least **35% of 50 marks, i.e., 18 marks.**
- Notwithstanding the above, a student is considered to have **passed the course**, provided the combined total of **CIE and SEE** is at least **40 out of 100 marks.**

Internal Assessment Test (IA) + Continuous Comprehensive Assessments (CCA) = Continuous Internal Evaluation CIE [25+25=50 marks]

- i) A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks.**
- ii) In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks.**

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students.** These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Case Study of container ships, tankers, LNG vessels, etc., focusing on their design, cargo handling, and real-world operations.	15
2.	Identify and demonstrate the use of appropriate fire extinguishers for different fire classes.	10

Continuous Internal Evaluation (CIE)

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

Passing requirement in SEE

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

Rubrics for Learning Activity 1: Case Study of container ships, tankers, LNG vessels, etc., focusing on their design, cargo handling, and real-world operations.					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Understanding of Case (PO 1)	Demonstrates deep understanding	Good understanding	Adequate understanding	Limited understanding	No clear understanding
Analysis & Critical Thinking (PO 2)	Thorough, logical analysis with strong reasoning and innovative insights.	Clear analysis with mostly logical reasoning.	Basic analysis with some reasoning gaps.	Weak analysis; mostly descriptive without reasoning.	No clear analysis or reasoning.
Presentation Skills & Organization (PO 10)	Well-structured, clear, confident delivery; excellent visuals.	Good structure, clear delivery; visuals mostly effective.	Average structure; delivery clear but lacks engagement.	Poor organization; visuals unclear.	Unclear, disorganized presentation.
Q&A Handling (PO 10)	Confident, accurate, and concise responses.	Good responses with minor gaps.	Adequate responses; some uncertainty.	Weak or hesitant responses.	Unable to answer questions.
Documentation (PO 10)	Documentation is complete, accurate, well-structured, follows all formatting guidelines.	Documentation is mostly complete and accurate, well-organized, follows formatting guidelines	Documentation covers most required elements but has some inaccuracies or omissions.	Documentation is incomplete with noticeable inaccuracies.	Documentation is largely missing or irrelevant, lacks structure.

		with minor deviations.			
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Rubrics for Learning Activity 2: Identify and demonstrate the use of appropriate fire extinguishers for different fire classes.					
Performance Indicator	Superior (5 Marks)	Good (4 Marks)	Fair (3 Marks)	Needs Improvement (2 Marks)	Unacceptable (1 Mark)
Extinguisher Selection & Suitability (PO 1)	Correct extinguisher type selected (CO ₂ , Foam, Dry Powder, etc.) exactly matching fire class (A, B, C, electrical, galley, etc.); strong justification with application (engine room, accommodation, cargo area).	Mostly correct selection with good justification.	Partially correct selection; justification incomplete.	Incorrect selection for fire type; weak reasoning.	Completely inappropriate extinguisher; no justification.
Technical Knowledge & Accuracy (PO 2)	Clear explanation of fire classes, extinguisher types, working principle, advantages/limitations, and safety precautions; all technically accurate.	Mostly accurate with minor errors.	Basic understanding; some gaps in explanation.	Several errors; important concepts missing.	Incorrect or very limited technical knowledge.
Application to Shipboard Scenarios (PO 1, PO 2)	Correctly applies extinguisher selection to different shipboard areas (engine room, cargo hold, paint store, galley, accommodation) with clear reasoning.	Good application with minor gaps.	Basic application; limited scenarios covered.	Poor linkage to shipboard conditions.	No application to shipboard scenarios.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Case Study	20
2.	Identify and demonstrate the use of appropriate fire extinguishers for different fire classes.	10
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	MOOCs/Video Lectures	18