Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-1 (B.Tech)

Subject: Essential Mathematics for Science and Engineering- BET2BT11210

Type of course: Major (Core)

Prerequisite: Elementary algebra, Higher secondary level trigonometry, logarithms, and exponential functions, Basic coordinate geometry, Fundamental arithmetic operations and number systems

Rationale: This course builds core mathematical tools essential for engineering practice Matrices and Determinants for handling structured data and systems of equations, Relations and Functions for understanding mappings, and Differentiation and Integration for analyzing change and accumulation. These concepts underpin applications across circuit analysis, computer graphics, mechanics, and system design. Through activity-based tasks alongside theory, the course develops both computational skill and the ability to apply these tools to real engineering problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
4	0	0	4	100	50	150

Course Content:

<table>
<tr><th>Sr. No</th><th>Course Content</th><th>Hrs.</th><th>Weightage</th></tr>
<tr><td>1</td><td>Matrix : Concept of a Matrix ,Types of matrices: Rectangular matrix, Square matrix, Null matrix, Diagonal matrix, Scalar matrix, Identity matrix, Singular and Non-singular matrix, symmetric and skew-symmetric matrices, Matrix operations : Addition, Subtraction and multiplication by scalar of matrices ,Rank of a matrix (basic introduction), Product of two matrices

<table>
<tr><th>Sr No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1</td><td>Quick Matrix Assessment</td><td>20</td><td></td></tr>
<tr><td>2</td><td>ALA: Matrix Lens (Video-Based Real-World Modeling)</td><td></td><td></td></tr>
<tr><td></td><td>Total:</td><td>20</td><td>10</td></tr>
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Description of ALA (10 Marks): Matrix Lens
In this ALA task, students will connect the abstract concept of matrices to tangible objects in their surroundings using digital media</td><td>12</td><td>20</td></tr>
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<td>and data modeling. Students will work individually or in small groups to capture and analyze real-world dimensions.
The task consists of two components:
• Video Capture (10–20 Seconds): Students will record a short video of items around them that naturally form rows and columns or hold multidimensional data. Examples include: parking lots (rows of cars), grocery store shelves (items vs. price points), digital screens (pixels), classroom seating arrangements, or a daily schedule tracker.
• Analytical Report: Along with the video, students will submit a brief report linking their footage to matrix algebra.
• The report must include:
• Video Snapshot: A screenshot or link to the recorded 10-20 second video.
• Matrix Construction: Representing the observed object/data as a mathematical matrix (defining its order, rows, and columns).
• Classification: Identifying what type of matrix it forms (e.g., Rectangular, Square, Diagonal, or Null matrix).
• Practical Application: A short narrative explaining how operations (like scalar multiplication for scaling quantities or addition for combining stock) would apply to their specific real-world matrix model.</td>
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<td>2</td>
<td>Determinants: Definition, Determinants values of 2nd and 3rd order, Minors and Cofactors of elements of matrix, Adjoint and Inverse of matrices of order 2nd and 3rd order. Elementary row and column operations on matrices, Characteristic equation and characteristic roots (Eigen values) of 2x2 matrix, Solution of Simultaneous linear equations of two variables
<table>
<tr><th>Sr No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1</td><td>Problem Design
Student creates an original determinant/inverse problem</td><td>10</td><td></td></tr>
<tr><td>2</td><td>Peer Solving
Student solves a classmate's problem & solution correctness check</td><td>10</td><td></td></tr>
<tr><td>3</td><td>Activity: Matrix Magic</td><td></td><td>10</td></tr>
<tr><td></td><td>Total:</td><td>20</td><td>10</td></tr>
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Description of Matrix Magic(10 Marks):
In this ALA task, students will explore the concept of determinants and inverses through a hands-on puzzle-solving and verification activity. Students will work individually or in small groups to connect determinant properties with real problem-solving scenarios.</td>
<td>12</td>
<td>20</td>
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<tr><td></td><td>The task consists of two components:
Puzzle/Problem Set: Students will be given a set of 2×2 and 3×3 matrices representing simple real-life scenarios (e.g., encoding/decoding a secret message, solving a small system of equations for resource allocation, or checking if a transformation is reversible).
Analytical Report: Students will submit a report that includes:
Determinant Calculation: Computing the determinant of the given matrix and stating whether it is singular or non-singular.
Adjoint & Inverse: Finding the adjoint and inverse of the matrix (where applicable).
Real-World Interpretation: Explaining what a zero determinant would mean in their scenario (e.g., no unique solution / non-reversible transformation).
Verification: Using the inverse to solve a simple simultaneous equation or "decode" their scenario, and verifying the result.
Students may present their solution as a short write-up, poster, or slide, and upload the final submission on ERP.</td><td></td><td></td></tr>
<tr><td>3</td><td>Relations And Functions: Ordered pairs, Cartesian product of sets, Number of elements in the Cartesian product of two finite sets, Definition of Function, Domain and Range of function, Types of Functions: Injective (One-to-One), Surjective (Onto), and Bijective Functions. Operations & Special Functions: Composite Functions, Inverse of a Function. Introduction to Elementary Functions: Trigonometric, Logarithmic, and Exponential Functions (including their Domains and Ranges).

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<tr><th>Sr No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1</td><td>Real-World Relation Hunt : Identify & document assigned mappings</td><td>10</td><td></td></tr>
<tr><td>2</td><td>Classification & Justification Report</td><td>10</td><td></td></tr>
<tr><td>3</td><td>Graph Sketching : Visualizing Functions: Learn by Interaction</td><td></td><td>10</td></tr>
<tr><td></td><td>Total:</td><td>20</td><td>10</td></tr>
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Description SEE: (20 Marks)
Faculty will assign each student/group a real-world relation from a prepared list (e.g., Aadhaar number → person, roll number → student, email ID → account, temperature sensor readings → time of day, vehicle number → owner, bank account number → account holder). Students will then analyze their assigned relation as a mathematical relation/function.
The report must include:</td><td>12</td><td>20</td></tr>
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Relation Identification: Description of the assigned pair, clearly stating the domain and codomain.
Function Test: Verifying whether the assigned relation qualifies as a function, and if so, classifying it as Injective, Surjective, or Bijective, with justification.
Composite/Inverse Check: Exploring whether a composite or inverse function makes practical sense for the assigned relation (e.g., can you reliably go from account → email?).
Conclusion: A short note on why such classification matters in real systems (e.g., database uniqueness, one-to-one mapping in ID systems).

Description of Graph Sketching(10 Marks):
Students will create a visual, activity-based assignment using non-coding tools such as charts, GeoGebra (graphical use only), PowerPoint, and posters to explore graph sketching and interpretation of functions and limits. The activity, approved by the faculty, assesses students' conceptual clarity, graphical interpretation, and visualization skills.
The assignment should include:
• Introduction to the selected function or concept
• Mathematical definition of the function
• Hand-drawn or tool-based graph sketch (using graph sheets, GeoGebra – graphical use only, spreadsheets, Canva, or PowerPoint)
• Identification of key features such as domain, range, intercepts, symmetry, and behavior near critical points
• Interpretation of function behavior using the graph (including limit behavior where applicable)
• Clear explanation and conclusion or learning outcome
• The assignment may be printed or digitally designed, and students may be required to briefly explain their work during evaluation and upload the final submission on ERP.
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Differentiation: Differentiation: Definition, Rules of Sum, Product, Division, Chain Rule, Derivatives of algebraic, trigonometric, logarithmic, exponential functions, Derivatives of inverse trigonometric functions (basic list), Successive Differentiation up to second order
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<tr><th>Sr No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1</td><td>Open-book Exam</td><td>20</td><td></td></tr>
<tr><td>2</td><td>ALA:
Error Spotting in Differentiation
Find & correct mistakes</td><td></td><td>10</td></tr>
<tr><td></td><td>Total:</td><td>20</td><td>10</td></tr>
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<td>12</td>
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<tr><td></td><td>Description of ALA (10 Marks):
In this ALA task, students will be given solved differentiation problems containing intentional errors. The errors may be conceptual, procedural, or calculation-based. Students are required to identify the mistakes and rewrite the correct solution. This task is designed to assess students' analytical ability, conceptual understanding, and attention to detail.
Each question will require students to clearly point out the error and provide the correct differentiation step.</td><td></td><td></td></tr>
<tr><td>5</td><td>Integration: Basic integration formulas, Integration by substitution, Integration by parts , Definite integrals, Basic properties of definite integrals, Evaluation of simple definite integrals, Area under curves (basic), Applications of integrals in simple real-life problems

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<tr><th>Sr No.</th><th>Evaluation Methods</th><th>SEE</th><th>CCE</th></tr>
<tr><td>1</td><td>Case Study Report (Problem, Tool, Result, Conclusion)</td><td>10</td><td></td></tr>
<tr><td>2</td><td>Presentation with Visual Demonstration (Tool-based)</td><td>10</td><td></td></tr>
<tr><td>3</td><td>Viva</td><td></td><td>10</td></tr>
<tr><td></td><td>Total:</td><td>20</td><td>10</td></tr>
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Description of SEE (20 Marks):

Case Study Report (Problem, Tool, Result, Conclusion) – 10 Marks

Students will select a real-life problem that can be solved using integration (e.g., calculating area under a curve, estimating accumulated quantity over time, or finding total distance from a velocity function). The report must be structured as follows:

• Problem: Clear statement of the real-world scenario and the mathematical question involved.
• Tool: The integration method/formula used to solve it (substitution, by parts, definite integral, etc.), including the function and limits considered.
• Result: Step-by-step solution with the final calculated value.
• Conclusion: Interpretation of the result in the context of the original problem, and its practical significance.

Presentation with Visual Demonstration (Tool-based) – 10 Marks

Students will prepare a short presentation (using PowerPoint, GeoGebra, spreadsheets, or hand-drawn visuals) demonstrating how integration is used to calculate area under a curve for a chosen</td><td>12</td><td>20</td></tr>
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	function. The presentation should include: • The function and its graph • Marking of the limits of integration on the graph • Visual representation of the shaded area under the curve • Step-by-step explanation of how the integral is set up and evaluated • A brief note connecting the result to a practical application Students may be required to present and explain their work live during evaluation.		

Suggested Specification table with Marks:

Distribution of Marks (Revised Bloom's Taxonomy)						
Level	**Remembrance (R)**	**Understanding (U)**	**Application (A)**	**Analyze (N)**	**Evaluate (E)**	**Create (C)**
Weightage %	15%	25%	30%	15%	10%	5%

Course Outcomes:

After learning the course, the students should be able to:	
CO1	Understand the concept of matrices and their operations to represent and solve real-world multidimensional data problems.
CO2	Compute determinants, minors, cofactors, and inverses of matrices, and apply them to solve simultaneous linear equations.
CO3	Analyze relations and functions, and classify them based on their mapping properties (injective, surjective, bijective).
CO4	Apply differentiation techniques to compute derivatives of algebraic, trigonometric, logarithmic, and exponential functions, and interpret rates of change.
CO5	Remember and apply integration techniques to evaluate definite integrals and compute areas under curves for practical applications.

Instructional Method:

The course will be delivered using traditional classroom teaching supported by active and application-based learning strategies appropriate for engineering students. In addition to blackboard teaching, the instructor will use:

- Lecture-based instruction supported by illustrative examples and problem-solving sessions
- Activity-Led Assignments (ALAs) for experiential and application-based learning

- Use of digital tools (GeoGebra, spreadsheets, PowerPoint, Canva) for visualization of mathematical concepts
- Peer learning through problem exchange and cross-verification activities
- Case study and model-based demonstrations to connect theory with real-world application
- Formative assessment through quizzes, open-book exams, and viva to reinforce conceptual understanding
- ERP-based submission and evaluation of assignments for structured tracking.

Reference Books:

[1]. Advanced Engineering Mathematics, By Erwin Kreyszig, Wiley India Pvt. Ltd.

[2]. Calculus and Analytical Geometry, By Thomas & Finney, Pearson / Addison-Wesley.

[3]. Higher Engineering Mathematics, By B. S. Grewal, Khanna Publishers, New Delhi.

[4]. Calculus: Early Transcendentals, By James Stewart, Cengage Learning India Pvt. Ltd

Suggestive Rubrics:

Suggestive Assessment Guidelines:
Module 1: **ALA: Matrix Lens – Video-Based Real-World Modeling:** **10 Marks:** Excellent content, accurate matrix construction, correct classification, clear real-world linkage and confident explanation **08 Marks:** Content correct, good video example, minor gaps in classification or explanation **05 Marks:** Basic matrix concept covered, weak real-life linkage or unclear video **02 Marks:** Very limited understanding, poorly structured report **00 Marks:** Incomplete / off-topic
Module 2: **Matrix Magic** **10 Marks:** Accurate matrix concepts, strong visuals, innovative real-life application **08 Marks:** Correct content, good visuals, limited application depth **05 Marks:** Basic matrix operations shown, weak explanation **02 Marks:** Minimal effort, unclear visuals **00 Marks:** Not submitted / incorrect
Module 3: **Graph Sketching – Visualizing Functions: Learn by Interaction:** **10 Marks:** Accurate graph, correct identification of domain/range/key features, clear interpretation and confident explanation **08 Marks:** Correct graph, good feature identification, minor gaps in interpretation **05 Marks:** Basic graph attempted, weak feature identification or interpretation **02 Marks:** Model incomplete or unclear **00 Marks:** Not submitted
Module 4: **ALA: Error Spotting in Differentiation:**

10 Marks: All errors correctly identified and corrected with justification **06 Marks:** Most errors identified, correction partly correct **03 Marks:** Few errors identified, weak correction **00 Marks:** Errors not identified
Module 5: **Case Study Report** **10 Marks:** Clear problem statement, correct tool/method application, accurate result, well-justified conclusion **08 Marks:** Correct approach, minor errors in result or conclusion **05 Marks:** Basic case study attempted, weak result or unclear conclusion **02 Marks:** Poorly structured, major errors in approach or result **00 Marks:** Not submitted / incorrect **Presentation with Visual Demonstration** **10 Marks:** Clear visual demonstration of Area Under Curve, correct use of tool, confident and well-explained presentation **08 Marks:** Correct demonstration, minor gaps in explanation or visual clarity **05 Marks:** Basic demonstration shown, weak explanation or unclear visuals **02 Marks:** Incomplete demonstration, poor visual/tool use **00 Marks:** Not submitted / incorrect **Viva** **10 Marks:** Thorough conceptual understanding, confident and accurate responses to all questions **08 Marks:** Good understanding, minor errors in responses **05 Marks:** Basic understanding, hesitant or partially correct responses **02 Marks:** Weak understanding, mostly incorrect responses **00 Marks:** Unable to respond / not attended