PKM EDUCATIONAL TRUST®

R R Institute of

RAJA REDDY LAYOUT, NEAR CHIKKABANAVARA RAILWAY STATION, CHIKKABANAVARA,

An Autonomous Institution under
Approved by AICTE, New Delhi & Government of

ACCREDITED
NAAC
NATIONAL ASSESSMENT AND
ACCREDITATION COUNCIL
NATIONAL BOARD OF

DEPARTMENT OF BASIC SCIENCE (MATHEMATICS)
CSE STREAM

Course Title:	**Calculus, Modular Arithmetic & Linear Algebra**	Semester	**I**
Course Code:	**BMATS101**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P: S)	3:1:2:0	Exam Hours	03
Total Hours of Pedagogy	40 hours Theory + 10 to12 Lab slots	Credits	04

Course learning objectives: The goal of the course for **Calculus, Modular Arithmetic & Linear Algebra** Computer Science and Engineeringstream is to

CLO 1. Familiarize the importance of calculus associated with one variable and multivariable forcomputer science and engineering.

CLO 2. Analyze Computer science and engineering problems by applying Ordinary DifferentialEquations.

CLO 3. Apply the knowledge of modular arithmetic to computer algorithms.

CLO 4. Develop the knowledge of Linear Algebra to solve the system of equations.

Teaching-Learning Process
Pedagogy (General Instructions):
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the 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 group learning 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).

Module-1: Calculus (8 hours)

Introduction to polar coordinates and curvature relating to Computer Science and Engineering.

Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and Radius of curvature - Cartesian, Pedal (Proof) Parametric, Polar(without proof) forms Problems.

Self-study: Center and circle of curvature, evolutes and involutes.
Applications: Computer graphics, Image processing.
(RBT Levels: L1, L2 and L3)

Module-2:Series Expansion and Multivariable Calculus (8 hours)

Introduction of series expansion and partial differentiation in Computer Science & Engineering applications.

Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems.

Indeterminate forms - L'Hospital's rule(without proof) $(1^\infty, 0^0, \frac{0}{0})$-Problems.

Partial differentiation, total derivative - differentiation of composite functions. Jacobian and problems. Maxima and minima for a function of two variables. Problems.

Self-study: Euler's theorem and problems. Method of Lagrange's undetermined multipliers withsingle constraint.
Applications: Series expansion in computer programming, Computing errors and approximations.
(RBT Levels: L1, L2 and L3)

Module-3: Ordinary Differential Equations (ODEs) of First Order (8 hours)

Introduction to first-order ordinary differential equations pertaining to the applications for Computer Science & Engineering.
Linear and Bernoulli's differential equations. Exact and reducible to exact differential equations-integrating factors on $1/N = (\partial M/\partial y - \partial N/\partial x)$ and $1/M = (\partial N/\partial x - \partial M/\partial y)$. Newton's Laws of cooling(problems).
Non-linear differential equations: Introduction to general and singular solutions, Solvable for p only, Clairaut's equations, reducible to Clairaut's equations. Problems.

Self-Study: Applications of ODEs, Solvable for x and y, Orthogonal trajectories.
Applications of ordinary differential equations: Rate of Growth or Decay, Conduction of heat.
(RBT Levels: L1, L2 and L3)

Module-4: Modular Arithmetic (8 hours)

Introduction of modular arithmetic and its applications in Computer Science and Engineering.
Introduction to Congruences, Linear Congruences, The Remainder theorem, Solving Polynomials, Linear Diophantine Equation, System of Linear Congruences, Euler's Theorem, Wilson Theorem and Fermat's little theorem (without proof)-problems. Applications of Congruences-Rivest-Shamir-Adleman (RSA) algorithm.

Self-Study: Divisibility, GCD, Properties of Prime Numbers, Fundamental theorem of Arithmetic.
Applications: Cryptography, encoding and decoding, RSA applications in public key encryption.
(RBT Levels: L1, L2 and L3)

Module-5: Linear Algebra (8 hours)

Introduction of linear algebra related to Computer Science &Engineering.
Elementary row transformation of a matrix, Rank of a matrix. Consistency and inconsistency and Solution of system of linear equations - Gauss-elimination method, Gauss-Jordan method and

approximate solution by Gauss-Seidel method. Rayleigh's power method to find the dominant Eigenvalue and Eigenvector(problems).

Self-Study: Solution of system of equations by Gauss-Jacobi iterative method. Inverse of a square matrix by Cayley- Hamilton theorem.
Applications: Boolean matrix, Network Analysis, Markov Analysis, Critical point of a network system. Optimum solution.
(RBT Levels: L1, L2 and L3).

List of Laboratory experiments (2 hours/week per batch/ batch strength 15)
10 lab sessions + 1 repetition class + 1 Lab Assessment

1. 2D plots for Cartesian and polar curves.
2. Finding angle between polar curves, curvature and radius of curvature of a given curve.
3. Finding partial derivatives and Jacobian.
4. Applications to Maxima and Minima of two variables.
5. Solution of first-order ordinary differential equation and plotting the solution curves.
6. Finding GCD using Euclid's Algorithm.
7. Solving linear congruences $ax \equiv b(mod\ m)$.
8. Numerical solution of system of linear equations, test for consistency and graphical Representation.
9. Solution of system of linear equations using Gauss-Seidel iteration.
10. Compute eigenvalues and eigenvectors and find the largest and smallest eigenvalue by Rayleigh power method.

Suggested software: Mathematica/MatLab /Python/Scilab

Course outcome (Course Skill Set)
At the end of the course the student will be able to:
1. Apply the knowledge of calculus to solve problems related to polar curves and learn the notion of partial differentiation to compute rate of change of multivariate functions.
2. Analyze the solution of linear and nonlinear ordinary differential equations.
3. Get acquainted and to apply modular arithmetic to computer algorithms.
4. Make use of matrix theory for solving the system of linear equations and compute eigenvalues and eigenvectors.
5. Familiarize with modern mathematical tools namely MATHEMATICA/MATLAB/ PYTHON/ SCILAB

Course Assessment and Evaluation Details (both CIE and SEE)

Continuous Internal Evaluation: 50 marks

Theory Assessment Tool	Marks	Reduced marks
IAT-1	50	15
IAT-2	50	
Assessment -1	10	10
Assessment -2(activity based)	10	
Lab Assessment Tool	**Marks**	**Reduced marks**
Conducting Experiment and Laboratory Record(10 labs)	15(each lab)	15
Lab Test	10	10

Semester End Examination (SEE) : 50 marks

SEE	Marks	Reduced marks
Course end examination (Answer any one question from each unit – Internal choice)	100	50

Suggested Learning Resources:

Text Books

1. **B. S. Grewal**: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.
3. **David M Burton**: "Elementary Number Theory" Mc Graw Hill, 7th Ed., 2017.

Reference Books

4. **V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
5. **Srimanta Pal & Subodh C.Bhunia**: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016.
6. **N.P Bali and Manish Goyal**: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
7. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017.
8. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education(India) Pvt. Ltd 2015.
9. **H. K. Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S. Chand Publication, 3rd Ed., 2014.
10. **James Stewart: "**Calculus" Cengage Publications, 7th Ed., 2019.
11. **David C Lay:** "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.
12. **Gareth Williams:** "Linear Algebra with Applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.
13. **Gilbert Strang:** "Linear Algebra and its Applications", Cengage Publications, 4th Ed. 2022.
14. **William Stallings:** "Cryptography and Network Security" Pearson Prentice Hall, 6th Ed., 2013.
15. **Kenneth H Rosen:** "Discrete Mathematics and its Applications" McGraw-Hill, 8th Ed. 2019.
16. **Ajay Kumar Chaudhuri:** "Introduction to Number Theory"NCBA Publications, 2nd Ed., 2009.
17. **Thomas Koshy:** "Elementary Number Theory with Applications"Harcourt Academic Press, 2nd Ed., 2008.

Web links and Video Lectures (e-Resources):

http://nptel.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/

COs and POs Mapping (Individual teacher has to fill up)

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1												
CO2												
CO3												
CO4												

CO5											

Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped