PKM EDUCATIONAL TRUST®
R R Institute of Technology
RAJA REDDY LAYOUT, NEAR CHIKKABANAVARA RAILWAY STATION, CHIKKABANAVARA,
An Autonomous Institution under VTU
Approved by AICTE, New Delhi & Government of Karnataka
ACCREDITED NAAC NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL NBA NATIONAL BOARD OF ACCREDITATION
Since 1993

DEPARTMENT OF BASIC SCIENCE (MATHEMATICS)

ME STREAM

Course Title:	**Calculus, Ordinary Differential equations & Linear Algebra**	Semester	**I**
Course Code:	**BMATM101**	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 **Calculus, Ordinary Differential equations & Linear Algebra** for Mechanical Engineering stream is to

CLO 1. Familiarize the importance of calculus associated with one variable and multivariable for Mechanical engineering.

CLO 2. Analyze Mechanical engineering problems by applying Ordinary Differential Equations.

CLO 3. 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 Mechanical Engineering applications.

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

Self-study: Center and circle of curvature, evolutes and involutes.
Applications: Applied Mechanics, Strength of Materials, Elasticity.
(RBT Levels: L1, L2 and L3)

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

Introduction of series expansion and partial differentiation in Mechanical 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: Computation of stress and strain, Errors and approximations in manufacturing process, Estimating the critical points and extreme values.
(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 Mechanical 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: L-R circuits. Solvable for x and y.
Applications of ordinary differential equations: Rate of Growth or Decay, Conduction of heat.
(RBT Levels: L1, L2 and L3)

Module-4:Ordinary Differential Equations of Higher Order(8 hours)

Importance of higher-order ordinary differential equations in Mechanical engineering applications.

Higher-order linear ODEs with constant coefficients ($e^{ax}, sinax, cosax$) - Inverse differential operator, method of variation of parameters, Cauchy's and Legendre homogeneous differential equations - Problems.

Self-Study: Formulation and solution of oscillations of a spring. Finding the solution by the method of undetermined coefficients.
Applications: Applications to oscillations of a spring, Mechanical systems and Transmission lines.
(RBT Levels: L1, L2 and L3)

Module-5: Linear Algebra (8 hours)

Introduction of linear algebra related to Mechanical engineering applications.

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.

Self-Study: Solution of system of equations by Gauss-Jacobi iterative method. Inverse of a square matrix by Cayley- Hamilton theorem.

Applications: Network Analysis, Balancing equations.

(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. **Solutions of Second-order ordinary differential equations with initial/ boundary conditions.**
7. Solution of differential equation of oscillations of spring with various load.
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.
2. Learn the notion of partial differentiation to compute rate of change of multivariate functions.
3. Analyze the solution of linear and nonlinear ordinary differential equations.
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, 44thEd., 2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10thEd., 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, 7thEd., 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

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