I SEMESTER

Course Title	**CALCULUS AND LINEAR ALGEBRA for civil engineering stream**			
Course Code	**23MATC11**		**CIE Marks**	**50**
Course Type	**Integrated**		**SEE Marks**	**50**
Teaching Hours/Week (L: T: P: S)	**2:2:2:0**		**Total Marks**	**100**
Total Hours of Pedagogy	**Theory**	**40 hours**	**Exam Hours**	**03**
	Practical	**10 to 12 slots**	**Credits**	**04**

Course objectives:

The goal of the course **Calculus and Linear Algebra for civil engineering stream** is to

- **Familiarize** the importance of calculus associated with one variable and two variables forcivil engineering.
- **Analyze** Civil engineering problems applying Ordinary Differential Equations.
- **Develop** the knowledge of Linear Algebra refereeing to matrices.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher 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 maybe 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 for 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

Differential Calculus:

Introduction to polar coordinates and curvature relating to Civil 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, Parametric, Polar and Pedal forms. Problems. **- 08 Hours**

Self-study: Center and circle of curvature, evolutes and involutes.

Applications: Structural design and paths, Strength of materials, Elasticity.

[Text 1: 4.7, 4.8, 4.10, 4.11]

(RBT Levels: L1, L2 and L3)

Module-2

Series Expansion and Multivariable Calculus:

Introduction to series expansion and partial differentiation in the field of Civil engineeringapplications.

Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems. Indeterminate forms-L'Hospital's rule. Problems.

Partial differentiation, total derivative-differentiation of composite functions. Jacobian and problems. Maxima and minima for a function of two variables. Problems. **-08 Hours**

Self-study: Euler's Theorem and problems. Method of Lagrange undetermined multipliers with single constraint.

Applications: Computation of stress and strain, Errors and approximations, Estimating the criticalpoints and extreme values.

[Text 1: 4.4, 4.5, 5.2, 5.5, 5.6, 5.7, 5.11]

(RBT Levels: L1, L2 and L3)

Module-3

Ordinary Differential Equations (ODE's) of first order:

Introduction to first-order ordinary differential equations pertaining to the applications for Civil engineering.

Linear and Bernoulli's differential equations. Exact and reducible to exact differential equations– Integrating factor on $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ and $\frac{1}{M}\left(\frac{\partial N}{\partial X}-\frac{\partial M}{\partial y}\right)$. Applications of ODE's- Orthogonal trajectories, Newton's law of cooling.

Nonlinear differential equations: Introduction to general and singular solutions; Solvable for p only; Clairaut's equations, reducible to Clairaut's equations- Problems. **-08 Hours**

Self Study: Applications of ODE's: bending of the beam and whirlingof shaft' Solution of non-linear ODE by the method of solvable for x and y.

Applications: Structural analysis, Dynamics, elasticity and earth quake engineering.

[Text 1: 11.9, 11.10, 11.11, 11.12, 11.13, 11.14, 12.3, 12.6]

(RBT Levels: L1, L2 and L3)

Module-4

Integral Calculus:

Introduction to Integral Calculus in Civil Engineering applications.

Multiple Integrals: Evaluation of double and triple integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates.

Beta and Gamma functions: Definitions, properties, the relation between Beta and Gamma functions. Problems. **- 08 Hours**

Self-study: Applications to find Area and Volume by a double integral. Problems. Centre of gravity.

[Text 1: 7.1, 7.2, 7.5, 7.7(2)(i), 7.14, 7.15, 7.16]

Applications: Applications to mathematical quantities (Area, Surface area, Volume), Analysis of probabilistic models.

(RBT Levels: L1, L2 and L3)

Module-5

Linear Algebra:

Introduction of linear algebra related to Civil Engineering applications.

Elementary row transformation of a matrix, Rank of a matrix. Consistency and Solution of system of linear equations; Gauss-elimination method, Gauss-Jordan method and Approximate solution by Gauss-Seidel method. Eigen values and Eigen vectors-Rayleigh's power method to find the dominant Eigen value and Eigen vector. **-8 Hours**

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

Applications: Structural Analysis, Balancing equations.

[Text 1: 2.7, 2.10, 2.13, 28.6, 28.7, 28.9]

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process for all modules	**Chalk and Talk/PowerPoint presentation/YouTube videos.**

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, Jacobian and plotting the graph
4	Applications to Maxima and Minima of two variables
5	Solution of first-order differential equation and plotting the graphs
6	Program to compute area, volume and centre of gravity
7	Evaluation of improper integrals
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 eigen values and eigen vectors and find the largest and smallest eigen value by Rayleigh power method.

Course Outcomes:

After successfully completing the course, the students 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. Solve first-order linear/nonlinear ordinary differential equations analytically using standard methods.
3. Understand the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing area and volume
4. Make use of matrix theory for solving for system of linear equations and Compute eigen values and eigen vectors
5. Use the modern mathematical tools by PHYTHON software.

Evaluation Details:

EvaluationType		Component	Max Marks	Marks Reduced to	Min. Marks	EvaluationDetails
Theory Component	Internal Assessment Tests(IAT)	IAT-1	25	15	10	Average of two IATs, Scaled down to 15 marks
		IAT-2	25			
	Comprehensive Continuous Evaluations (CCE)	CCE-1	10	10		Any two Assessmentmet as per 22OB4.2 of regulations, Average of two CCEs, scaled Down to 10marks
		CCE-2	10			
	Total CIE -Theory			**25**	**10**	Scale down marks of IAT and CCE to25
Laboratory Component	PracticalandLabRecord	-	15	25	10	Conduction of experimnts and preparation of Lab records, etc
	LabTest	50	10			One test to be conducted after the completion of All lab experiments.
	TotalCIE –Practical			**25**	**10**	
TotalCIE(Theory+Lab)				**50**	**20**	
SEE			100	**50**	**18**	Conducted for 100 marks and scaled down to 50.
CIE + SEE				**100**	**40**	

Suggested Learning Resources:

Text Books:

1. **B. S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

Reference Books:

1. **B.V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal & Subodh C.** Bhunia: "Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022..
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co. Newyork, 6th Ed., 2017.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education(India) Pvt. Ltd 2015.
6. **H.K. Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S.Chand Publication 3rd Ed., 2014.
7. **James Stewart: "**Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

E-Resources:

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

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

- Quizzes
- Assignments
- Seminars

CO- PO Mapping :

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BMATC101.1	2	1										
BMATC101.2	3	2										
BMATC101.3	3	1										
BMATC101.4	3	3										**1**
BMATC101.5	1	2			**3**							
Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped												