

Course Title:	Mathematics for Civil Engineering Stream		
Course Code:	22MATC11	CIE Marks	50
Course Type(Theory/Practical/Integrated)	Integrated	SEE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:2:0	Total Marks	100
Total Hours of Pedagogy	40hoursTheory+10-12Lab slots	Exam Hours	03+02
		Credits	04

Course objectives: The goal of the course Advanced Calculus, Transforms and Numerical methods (22MATC11) is to

- Familiarize the importance of series expansion and Vector calculus essential for civil engineering.
- Analyze Civil engineering problems applying Partial derivatives and understand the value of limit (continuity) of function by using indeterminate forms.
- Develop the knowledge of polar curves to trace different types of curves.
- Applications of first order first degree differential equations.
- To develop the knowledge of matrices and linear algebra in a comprehensive manner.

### 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 student's 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 and quizzes, and documenting students' progress.
5. Five assignment problems on each module.
6. Encourage the students for group learning to improve their creative and analytical skills.
7. 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).

#### Course outcome (Course Skill Set)

At the end of the course the student will be able to:

C01	Learn the notion of partial differentiation to compute rate of change multivariate functions and understand the concept of Indeterminate forms.
C02	Illustrate the applications of multivariate calculus to understand the solenoidal and irrotational vectors and know the expansions of functions in power series form.
C03	Apply the knowledge of calculus to solve problems related to polar curves and graphical representation of different curves.
C04	Solve first order linear/nonlinear differential equation analytically using standard methods and express the solution in graphical form.
C05	Make use of matrix theory for solving for system of linear equations and compute Eigen values and Eigen vectors by using computational software's.
C06	Learn with modern mathematical tools namely SCILAB /PYTHON /MATLAB /

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**Bloom's level of the course outcomes:**

CO#	Bloom's Level					
	Remember (L1)	Understand (L2)	Apply (L3)	Analyze (L4)	Evaluate (L5)	Create (L6)
CO1	✓	✓	✓			
CO2	✓	✓	✓			
CO3	✓	✓	✓			
CO4	✓	✓	✓			
CO5	✓	✓	✓			

**Course Articulation Matrix / Course mapping :**

CO#	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PS02	PS03
CO1	3	2	2		1				1			1			
CO2	3	2	2		1				1			1			
CO3	3	2	2		1				1			1			
CO4	3	2	2		1				1			1			
CO5	3	2	2		1				1			1			

Note: 1-Low mapped, 2-Medium mapped, 3-High mapped

**MODULE-1 : INDETERMINATE FORMS AND PARTIAL DIFFERENTIATION**

**Introduction to Indeterminate forms and Partial differentiation relating to Civil Engineering.**

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.

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

**Applications:** Computation of stress and strain, Errors and approximations, Estimating the critical points and extreme values.

(RBT Levels: L1, L2 and L3)

(8 Hours)

**MODULE-2 : SERIES EXPANSION AND VECTOR CALCULUS**

**Introduction to Series expansion and Vector Calculus in Civil Engineering applications.**

Taylor's and Maclaurin's series expansions for one variable (statements only)- Problems

Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, divergence and curl - physical interpretation, solenoidal and irrotational vector fields. Problems.

Self-Study: Velocity and acceleration of a moving particle.

Applications: Heat and mass transfer, oil refinery problems, environmental engineering.

(RBT Levels: L1, L2 and L3)

(8 Hours)

**MODULE-3: DIFFERENTIAL CALCULUS**



**Introduction to polar coordinates and curvature in Civil Engineering applications.**

Polar coordinates, Polar curves, angle between the radius vector and tangent, angle between two curves. Pedal equations. Curvature and Radius of curvature - Cartesian, Parametric, Polar and Pedal forms. Problems.

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

**Applications:** Angle of elevation and survey engineering.

(RBT Levels: L1, L2 and L3)

(8 Hours)

**MODULE- 4: LINEAR AND NON-LINEAR ORDINARY DIFFERENTIAL EQUATION OF FIRST ORDER**

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

Exact and reducible to exact differential equations - Integrating factors type-1.

Applications of ODE's - Orthogonal trajectories, Conduction of heat, Newton's law of cooling. Problems.

**Self-Study:** Applications of ODE's, Solvable for x, y and p.

**Applications of ordinary differential equations:** Rate of Decay and growth.

(RBT Levels: L1, L2 and L3)

(8 Hours)

**MODULE- 5: LINEAR ALGEBRA**

**Introduction of liner algebra related to Civil Engineering applications.**

Elementary row transformation of a matrix, Rank of a matrix. Consistency and solution of a system of linear equations - 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.

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

Applications of Linear Algebra: Optimum solution.

(RBT Levels: L1, L2 and L3)

(8 Hours)

**List of Laboratory experiments (2 hours/week per batch/ batch strength 15)**

**10 lab sessions + 1 repetition class + 1 Lab Assessment**

1	Finding the sum of the series up to infinity
2	Finding the given series convergent and divergent
3	Evaluating the limits
4	Finding the Partial derivatives of a given function Finding partial derivatives, Jacobian and plotting the graph
5	Applications to Maxima and Minima of two variables
6	2D plots for Cartesian and polar curves Finding of intersection between two polar curves
7	Finding the angle between the radius vector and the tangent
8	Finding the pedal equation of the polar curves
9	Finding radius of curvature of a given curve
10	Solution of first order differential equation and plotting the graphs
11	Program to compute area, volume and centre of gravity
12	Solving the Linear differential equations

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13	Evaluating the rank of matrix
14	Numerical solution of system linear equations, test for consistency.

**Suggested software's:** Mathematica/MatLab/Python/Scilab

### **Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing marks for the CIE is 45% of the maximum marks (22.5 marks out of 50). The minimum passing marks for the SEE is 35% of the maximum marks (18 marks out of 50).

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and 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):**

The CIE shall be conducted by the course teacher throughout the semester. The CIE marks for the theory component of the IC shall be 30 marks and for the laboratory component 20 Marks. The CIE marks for the theory component shall be 50 marks and scored will be reduced to 30.As below

- Three Tests each of 15 Marks; after the completion of the syllabus of 35-40%, 65-70%, and 90-100% respectively. Average of Best Two performances of the Internal Tests shall be considered for 15 Marks.
- Session wise assignments for 25 marks
- For Seminar and library work 05 marks
- Attendance 5 marks (95% to 100%), 04 marks (85% to 94%)

### **CIE for the practical component of the IC:**

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The 35 marks are for conducting the experiment and preparation of the laboratory record, the other 15 marks shall be for the test conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 50 marks. Marks of all experiments' write-ups are added and scaled down to 20 marks.

### **Semester End Examination(SEE)**

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question carries 20 marks.
4. There will be two full questions (with a maximum of three sub questions) from each module
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.



**Suggested Learning Resources:**

**Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)Text Books**

1. **B.S.Grewal:** "Higher Engineering Mathematics", Khanna publishers, 44<sup>th</sup> Ed., 2021.
2. **E. Kreyszig:** "Advanced Engineering Mathematics", John Wiley & Sons, 10<sup>th</sup> Ed., 2018.

**Reference Books**

1. **V.Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11<sup>th</sup> Ed., 2017
2. **Srimanta Pal & Subodh C. Bhunia:** "Engineering Mathematics" Oxford University Press, 3<sup>rd</sup> Ed., 2016.
3. **N.PBali and Manish Goyal:** "A textbook of Engineering Mathematics" Laxmi Publications, 10<sup>th</sup> Ed., 2022.
4. **C.Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw-Hill Book Co., New york, 6<sup>th</sup> Ed., 2017.
5. **C.B Gupta, S. R Singh 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, 3<sup>rd</sup> Ed., 2014.
7. **James Stewart:** "Calculus" Cengage Publications, 7<sup>th</sup> Ed., 2019.
8. **David Clay:** "Linear Algebra and its Applications", Pearson Publishers, 4<sup>th</sup> Ed., 2018.
9. **Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6<sup>th</sup> Ed., 2017.