Course Title:	Mathematics for Mechanical Engineering Stream-II		
Course Code:	22MATM21	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Integrated	SEE Marks	50
		Total Marks	100
Teaching Hours/ Week	2:2:2:0	Exam Hours	03+02
Total Hours of Pedagogy	40hoursTheory+10-12Lab slots	Credits	04

Course objectives : The goal of the course **Advanced Calculus, Transforms and Numerical methods (22MATM21)**is to

- **Familiarize** the importance of Integral calculus and Vector calculus essential for mechanical engineering.
- **Analyze** mechanical engineering problems applying Partial Differential Equations.
- **Develop** the knowledge of solving mechanical engineering problems numerically.

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:

CO1	Apply the knowledge of Integral calculus to solve Double and Triple Integral for evaluating surface area and volume related to Mechanical Engineering.
CO2	Illustrates the Applications of Multivariate calculus to understand the solenoidal and irrational vectors and also exhibit the inter dependence of line, surface and volume integrals.
CO3	Construct a variety of Partial Differential Equations for the problems in mechanical engineering.
CO4	Apply the concept of numerical techniques to solve algebraic and non-algebraic equations for solving mechanical engineering problems.
CO5	Demonstrate the various physical modules in mechanical engineering through higher order differential equations.
CO6	Modern mathematical tools namely SCILAB /PYTHON /MATLAB / MATHEMATICA to solve problems in mechanical engineering.

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#	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 : Definite Integrals and Improper Integrals.

Introduction to Integral Calculus in Mechanical Engineering applications.

Multiple Integrals: Evaluation of double and triple integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates. Applications to find: Area and Volume by double integral. Problems.

Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions. Problems.

Self-Study: Volume by triple integration, Center of gravity.

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

(RBT Levels: L1, L2 and L3) (8 hours)

Module-2 :Vector Calculus

Introduction to Vector Calculus in Mechanical Engineering applications.

Vector Integration: Line integrals, Surface integrals. Applications to work done by a force and flux. Statement of Green's theorem, Stoke's theorem and Gauss divergence theorem and Problems.

Self-Study: Volume integral and Proof of Green's theorem, Stoke's theorem and Gauss divergence theorem.

Applications: Heat and mass transfer, oil refinery problems, environmental engineering. Analysis of stream lines.

(RBT Levels: L1, L2 and L3) (8 hours)

Module-3: Partial Differential Equations (PDE's)

Importance of partial differential equations for Mechanical Engineering application.
Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Solution of Lagrange's linear PDE. Derivation of one-dimensional heat equation and wave equation.
Self-Study: Solution of one-dimensional heat equation, wave equation by the method of separation of variables and Charpits method.
Applications: Design of structures (vibration of rod/membrane).
(RBT Levels: L1, L2 and L3) (8 hours)

Module-4 :Numerical methods

Importance of numerical methods for discrete data in the field of Mechanical Engineering.
Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson methods (only formulae). Problems.
Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula (All formulae without proof). Problems.
Numerical integration: Trapezoidal, Simpson's $(1/3)^{rd}$ and $(3/8)^{th}$ rules (without proof). Problems.

Self-Study: Bisection method, Lagrange's inverse Interpolation and Weddles rule.
Applications: Estimating the approximate roots, extreme values, Area, volume, surface area. Finding approximate solutions to Mechanical engineering problems.
(RBT Levels: L1, L2 and L3) (8 hours)

Module-5 : Ordinary Differential Equation

Introduction to Linear ordinary differential equations of second and Higher order for handling Mechanical Engineering applications.
Solution of second and higher order Ordinary Linear Differential Equations with constant coefficients, Inverse Differential Operator Method, Variation of Parameters method, applications of Differential equations LCR Circuits.

Self-Study: Singular Solutions and ODE with variable co-efficient.
Applications: Application of second order ODE, initial conditions and initial value problems.
(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	Evaluation of Double and triple integrals.
2	Evaluation of Beta and Gamma functions.
3	Finding surface integrals
4	Evaluation of surface area by Green's theorem.
5	Formation of PDE w.r.t. one independent variable.
6	Solution of PDE by direct integration.
7	Newton's forward and Backward interpolation formula.
8	Solution of numerical integration by Simpson's $(1/3)^{rd}$ rule.
9	Finding the roots for second order ODE.
10	Finding the roots by the method of variation of parameter.

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, 44th Ed., 2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.

Reference Books

1. **V.Ramana:**"Higher Engineering Mathematics" McGraw-Hill Education,11th Ed.,2017
2. **Srimanta Pal & Subodh C. Bhunia**: "Engineering Mathematics" Oxford University Press, 3rdEd., 2016.
3. **N.PBali 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., New york, 6thEd., 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, 3rdEd., 2014.
7. **James Stewart:** "Calculus" Cengage Publications, 7thEd., 2019.
8. **David CLay:** "Linear Algebra and its Applications", Pearson Publishers, 4th Ed.,2018.
9. **Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6thEd., 2017.