II Semester

22MATC21	Mathematics-2 for Civil	(2-2-2)4

Contact Hours:40 Theory + 12 Lab Sessions

Course Learning Objectives(CLO's):

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

Course Out Comes(CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-1	. Apply the knowledge of numerical methods in solving physical and engineering phenomena			1,2,12
CO-2	Apply the knowledge of multiple integrals to compute area and			1,2,12
CO-3	Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line.			1,2,12
CO-4	Demonstrate partial differential Equations and their solutions for physical interpretations.			1,2,12
CO-5	Get familiarize with modern mathematical tools namely Mathematica/MatLab/Python/Scilab		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			2							1

Pre- requisites: Knowledge of fundamentals of calculus.

Unit-1 (Numerical Methods-I)

Importance of numerical methods for discrete data in the field of Civil 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.
Applications: Estimating the approximate roots, extremum values, Area, volume, and surface area. Finding approximate solutions to civil engineering problems**.**

8 Hrs.

Unit-2 (Numerical Methods-II)

Introduction to various numerical techniques for handling Civil Engineering a pplications.

Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree-Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor- corrector formula(No derivations of formulae). Problems.

Self-Study: Adam-Bash forth method.
Applications: Finding approximate solutions to ODE related to civil engineering fields. **8 Hrs.**

Unit-3 (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. Applications to find Area and Volume by multiple integral. Problems.
Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions. Problems.

Self-Study: Volume by triple integration, Centre of gravity.
Applications: Applications to mathematical quantities (Area, Surface area, Volume), Analysis of physical models. **8 Hrs.**

Unit-4 (Vector Calculus)

Introduction to Vector Calculus in Civil Engineering applications.

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

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

Self-Study: Volume integral and Gauss divergence theorem.

Applications: Heat and mass transfer, oil refinery problems, environmental engineering. Analysis of streamlines, velocity and acceleration of a moving particle. **8 Hrs.**

Unit-5 (Partial Differential Equations)

Importance of partial differential equations for Civil Engineering applications.

Formation of PDE's by elimination of arbitrary constants and functions. Solution of non- homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives 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 and wave equation by the method of separation of variables.

Applications: Design of structures (vibration of rod/membrane) **8 Hrs.**

List of Laboratory experiments

(2hours/week per batch/batchstrength15)10 lab sessions + 1repetitionclass + 1LabAssessment

1. Solution of algebraic and transcendental equations by Regula-Falsi and Newton- Raphson method.
2. Interpolation/Extrapolation using Newton's forward and backward difference formula.
3. Program to compute surface area, volume and centre of gravity
4. Evaluation of improper integrals.
5. Finding gradient, divergent, curl and their geometrical interpretation.
6. Computation of area under the curve using Trapezoidal, Simpson's(1/3)rd and (3/8)th rule
7. Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
8. Solution of ODE of first order and first degree by Runge-Kutta4th order and Milne's predictor-corrector method.
9. Verification of Green's theorem.
10. Solution of one-dimensional heat equation and wave equation.

Reference Books

1. **B.S.Grewal**:"Higher Engineering Mathematics",Khannapublishers, 44thEd.,2021.
2. **E.Kreyszig**:"Advanced Engineering Mathematics", JohnWiley&Sons,10th Ed.,2018.
3. **V.Ramana**:"Higher Engineering Mathematics" McGraw-Hill Education,11th Ed.,2017.
4. **SrimantaPal &SubodhC. Bhunia**: "EngineeringMathematics" Oxford UniversityPress, 3rdEd.,2016.
5. 3. **N.P Baliand Manish Goyal**: "A textbook of Engineering Mathematics"Laxmi Publications,10th Ed.,2022.

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/
- VTUe-Shikshana Program
- VTU EDUSAT Program

I Semester

22MATE11	Mathematics-I for Electrical & Electronics Stream	(2-2-2)4

Contact Hours:40

Course Learning Objectives (CLOs):

- **Familiarize** the importance of calculus associated with one variable and multi-variable for Electrical & Electronics Engineering.
- **Analyze** Electrical & Electronics engineering problems by applying Ordinary Differential Equations.
- **Develop** the knowledge of Linear Algebra to solve the system of equations.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be Able to:		Mapping to Pos(1-12)/PSOs (1,2)		
		Substantial Level(3)	Moderate Level(2)	Slight Level(1)
CO-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 multi variate functions.	--	--	1
CO-2	Analyze the solution of linear and nonlinear ordinary differential equations.	--	--	1
CO-3	Apply the concept of change of order of integration and variables to evaluate multiple Integrals and their usage in computing area and volume.	--	2	--
CO-4	Make use of matrix theory for solving for system of linear equations and compute Eigen values and Eigen vectors	--	--	1
CO-5	Familiarize with modern mathematical tools namelyMathematica /Matlab /Python/Scilab	--	2,5	--

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	2	--	---	2	--	--	--	--	--	--	--

Pre- requisites: Knowledge of fundamentals of calculus.

Course Contents:

Unit–1(Calculus)

Introduction to polar coordinates and curvature relating to EC & EE 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, Parametric, Polar and Pedal forms. Problems.

Self study: Centre and circle of curvature, evolutes and involutes.

Applications: Communication theory, signals processing and Image Processing. **08Hrs.**

Unit–2 (Series Expansion and Multivariable Calculus)

Introduction of series expansion and partial differentiation in EC & EE Engineering Applications: 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 and Problems.

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

Applications: Errors and approximations, vector calculus and related applications in communication theory and signals processing. **08Hrs.**

Unit–3 (Ordinary Differential Equations(ODEs) of First Order)

Introduction to first-order ordinary differential equations pertaining to the applications for EC& EE Engineering: Linear and Bernoulli's differential equations. Exact and reducible to exact differential equations-

Integrating factors 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: Orthogonal

Trajectories(Cartesian) and R-L circuits, Problems.

Non-linear differentia 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.

Applications of ordinary differential equations: Rate of Growth or decay, Conduction of heat. **08Hrs.**

Unit-4 (Linear Algebra)

Introduction of linear algebra and Engineering Applications related to EC & EE: 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.

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

Applications of Linear Algebra: Network Analysis, Markov Analysis, Critical point of a network system. Optimum solution. **08Hrs.**

Unit–5 (Integral Calculus)

Introduction to Integral Calculus in EC and EE 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 integrals. Problems.

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

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

Applications: Antenna and wave propagation, Calculation of optimum power in electrical circuits, field theory. **08Hrs.**

List of Laboratory experiments (2 hours/week per batch/batch strength15)

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 Numerical solution of system of linear equations, test for consistency and graphical representation.
7 Solution of system of linear equations using Gauss-Seidel iteration method
8 Compute eigen values and eigen vectors and find the largest and smallest eigen value by Rayleigh power method.
9 Program to compute area, volume and centre of gravity.
10 Evaluation of improper integrals.

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

Reference Books:

1. **B. S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44th edition, 2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.
3. **Gupta C. B, Sing S. R and Mukesh Kumar:**"Engineering Mathematic for Semester I and II", Mc- Graw Hill Education (India) Pvt.Ltd 2015.
4. **H.K. Dass and Er.Rajnish Verma:**"Higher Engineering Mathematics", S.Chand Publication, 3rd Ed.,2014.
5. **Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.

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- http://academicearth.org/
- VTUe-Shikshana Program
- VTU EDUSAT Program

II Semester

22MATE21	Mathematics-2 for Electrical & Electronic Stream	(2-2-2)4

Contact Hours:40 Theory + 12 Lab Sessions

Course Learning Objectives (CLO's):

- **Develop** the knowledge of solving electronics and electrical engineering problems numerically.
- **Familiarize** the importance of Integral calculus and Vector calculus essential for electronics and electrical engineering.
- **Analyse** Electronics and Electrical Engineering problems by applying Partial DifferentialEquations.

Course outcomes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO1	Apply the knowledge of numerical methods in solving physical and engineering phenomena.			1,2,12
CO2	To understand the concept of Laplace transform and to solve initial value problems.			1,2,12
CO3	Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line Integral and surface integral.			1,2,12
CO4	Demonstrate the idea of Linear dependence and independence of sets in the vector space, And linear transformation			1,2,12
CO5	Get familiarize with modern mathematical tools namely SCILAB/PYTHON/MATLAB		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			2							1

Pre- requisites: Knowledge of fundamentals of calculus.

Unit-1 (Numerical methods -1)

Importance of numerical methods for discrete data in the field of EC&EE Engineering Applications.

Solution of algebraic and transcendental equations: Regula-Falsi method and Newton-Raphson method (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.

N**umerical integration**: Trapezoidal, Simpson's $(1/3)^{rd}$and $(3/8)^{th}$rules (without proof). Problems.

S**elf-Study:** Bisection method, Lagrange's inverse Interpolation, Weddle's rule.

Applications: Estimating the approximate roots, extremum values, Area, volume, and surface area. **8 Hrs.**

Unit-2 (Numerical Methods -2)

Introduction to various numerical techniques for handling EC& EE Applications.

Numerical Solution of Ordinary Differential Equations (ODEs):

Numerical solution of ordinary differential equations of first order and first degree - Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor- corrector formula (No derivations of formulae). Problems.

Self-Study: Adam-Bashforth method.

Applications: Estimating the approximate solutions of ODE for electric circuits. **8 Hrs.**

Unit-3 (Laplace Transform)

Importance of Laplace Transform for EC &EE Engineering Applications.

Existence and Uniqueness of Laplace transform (LT), transform of elementary functions, region of convergence, Properties–Linearity, Scaling, t-shift property, s-domain shift, differentiation in the s-domain, division by t, differentiation and integration in the time domain, LT of special functions- periodic functions(square wave, saw-tooth wave, triangular wave, full & half wave rectifier), Heaviside Unit step function, Unit impulse function.

Inverse Laplace Transforms:

Definition, properties, evaluation using different methods, convolution theorem (without proof), problems, and Applications to solve ordinary differential equations.

Self-Study: Verification of convolution theorem.

Applications: Signals and systems, Control systems, LR, CR & LCR circuits. **8 Hrs.**

Unit-4 (Vector Calculus)

Introduction to Vector Calculus in EC&EE Engineering Applications.

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

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

Self-Study: Volume integral and Gauss divergence theorem.

Applications: Conservation of laws, Electrostatics, Analysis of stream lines and electric potentials. **8 Hrs.**

Unit-5 (Vector Space and Linear Transformations)

Importance of Vector Space and Linear Transformations in the field of EC&EE Engineering Applications.

Vector spaces: Definition and examples, subspace, linear span, linearly independent and dependent sets, Basis and dimension.

Linear Transformations: Definition and examples, Algebra of transformations, Matrix of a linear transformation. Change of coordinates, Rank and nullity of a linear operator, Rank-Nullity theorem. Inner product spaces and orthogonality.

.

Self-study: Angles and Projections. Rotation, reflection, contraction and expansion.

Applications: Image processing, AI & ML, Graphs and networks, computer graphics.

8 Hrs.

List of Laboratory experiments

(2hours/week per batch/batchstrength15)10 labsessions + 1repetitionclass + 1LabAssessment

1. Solution of algebraic and transcendental equations by Regula-Falsiand Newton-Raphsonmethod.
2. Interpolation/Extrapolation using Newton's forward and backward difference formula.
3. Computation of area under the curve using Trapezoidal, Simpson's(1/3)rd and (3/8)th rule
4. Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
5. Solution of ODE of first order and first degree by Runge-Kutta 4th order and Milne's predictor-corrector method.

6. Computing inverse Laplace transform of standard functions.
7. Laplace transform of convolution of two functions.
8. Finding gradient, divergent, curl and their geometrical interpretation. Verification of Green's theorem.
9. Computation of basic and dimension for a vector space and Graphical representation of linear transformation.
10. Visualization in time and frequency domain of standard functions.

Reference 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. **N.P Bali and Manish Goyal**:"Atext book of Engineering Mathematics" LaxmiPublications,10th Ed., 2022.
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- http://academicearth.org/
- VTUe-Shikshana Program
- VTU EDUSAT Program

I Semester

22MATC11	Mathematics-I for Civil Engineering stream	(2:2:2:0)4

Contact Hours: 40 Theory + 12 Lab Sessions

Course Learning objectives (CLO's):

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

Course outcome (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Apply the knowledge of calculus to solve problems related to polar curves.			1,2,12
CO-2	Learn the notion of partial differentiation to compute rate of change of multivariate functions.			1,2,12
CO-3	Make use of matrix theory for solving for system of linear equations and compute Eigen values and Eigenvectors			1,2,12
CO-4	Analyze the solution of linear and non-linear ordinary differential equations.			1,2,12
CO-5	Familiarize with modern mathematical tools namely Mathematica/Matlab/ Python/Scilab		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			2							1

Pre- requisites: Knowledge of fundamentals of calculus.

Unit-1 (Calculus)

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

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

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

8 Hrs.

Unit-2 (Series Expansion and Multivariable Calculus)

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

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.

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. **8 Hrs.**

Unit-3 (Ordinary Differential Equations (ODEs) 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 factors on $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial M}{\partial x}\right)$ and $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial M}{\partial x}\right)$.Orthogonal trajectories (cartesian) and LR -Circuits.

Non linear differential equations: Introduction to general and singular solutions, Solvable for p only, Clairaut's equations. -Problems.

Self-Study: Applications of ODEs in Civil Engineering problems like bending of the beam, whirling of shaft, solution of non-linear ODE by the method of solvable for x and y.

Applications: Rate of Growth or Decay, Conduction of heat. **8 Hrs.**

Unit-4 (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 a system of linear equations-Gauss-elimination method, Gauss-Jordan method and approximate solution by Gauss-Seidel method. Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant eigenvalue and the corresponding eigenvector.

Self-Study: Solution of a system of linear equations by Jacobi iterative method. Inverse of a square matrix by Cayley- Hamilton theorem.
Applications: Structural Analysis, Balancing equations. **8 Hrs.**

Unit –5 (Ordinary Differential Equations of higher order)

Importance of higher-order ordinary differential equations in Civil Engineering applications.

Higher-order linear ODEs with constant coefficients-Inverse differential operator, method of variation of parameters, Cauchy's and Lagender's homogeneous differential equations-Problems.

Self-Study: Formulation and solution of Cantilever beam. Finding the solution by the method of undetermined coefficients.
Applications: Oscillations of a spring, Transmission lines, Highway engineering. **8 Hrs.**

List of Laboratory experiments (2hours/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. Numerical solution of system of linear equations, test for consistency and graphical representation.
7. Solution of system of linear equations using Gauss-Seidel iteration.
8. Compute eigenvalues and eigenvectors and find the largest and smallest eigenvalue by Rayleigh power method.
9. Solutions of Second-order ordinary differential equations with initial/boundary conditions.
10. Solution of a differential equation of oscillations of a spring/deflection of a beam with different loads.

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

Reference Books:

1. **B. S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44thEd.,2021.
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10^{th}Ed.,2018.
3. **V. Ramana**: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017.
4. **N. P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" LaxmiPublications,10th Ed., 2022.
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I Semester

22MATC11	Mathematics-I for Civil Engineering stream	(2:2:2:0)4

Contact Hours: 40 Theory + 12 Lab Sessions

Course Learning objectives (CLO's):

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

Course outcome (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Apply the knowledge of calculus to solve problems related to polar curves.			1,2,12
CO-2	Learn the notion of partial differentiation to compute rate of change of multivariate functions.			1,2,12
CO-3	Make use of matrix theory for solving for system of linear equations and compute Eigen values and Eigenvectors			1,2,12
CO-4	Analyze the solution of linear and non-linear ordinary differential equations.			1,2,12
CO-5	Familiarize with modern mathematical tools namely Mathematica/Matlab/ Python/Scilab		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			1							1

Pre- requisites: Knowledge of fundamentals of calculus.

Unit-1 (Calculus)

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

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

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

8 Hrs.

Unit-2 (Series Expansion and Multivariable Calculus)

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

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.

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. **8 Hrs.**

Unit-3 (Ordinary Differential Equations (ODEs) 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 factors on $\frac{1}{M}\left(\frac{\partial M}{\partial y}-\frac{\partial M}{\partial x}\right)$ and $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial M}{\partial x}\right)$.Orthogonal trajectories (cartesian) and LR -Circuits.

Non linear differential equations: Introduction to general and singular solutions, Solvable for p only, Clairaut's equations. -Problems.

Self-Study: Applications of ODEs in Civil Engineering problems like bending of the beam, whirling of shaft, solution of non-linear ODE by the method of solvable for x and y.

Applications: Rate of Growth or Decay, Conduction of heat. **8 Hrs.**

Unit-4 (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 a system of linear equations-Gauss-elimination method, Gauss-Jordan method and approximate solution by Gauss-Seidel method. Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant eigenvalue and the corresponding eigenvector.

Self-Study: Solution of a system of linear equations by Jacobi iterative method. Inverse of a square matrix by Cayley- Hamilton theorem.
Applications: Structural Analysis, Balancing equations. **8 Hrs.**

Unit –5 (Ordinary Differential Equations of higher order)

Importance of higher-order ordinary differential equations in Civil Engineering applications.

Higher-order linear ODEs with constant coefficients-Inverse differential operator, method of variation of parameters, Cauchy's and Lagender's homogeneous differential equations-Problems.

Self-Study: Formulation and solution of Cantilever beam. Finding the solution by the method of undetermined coefficients.
Applications: Oscillations of a spring, Transmission lines, Highway engineering. **8 Hrs.**

List of Laboratory experiments (2hours/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. Numerical solution of system of linear equations, test for consistency and graphical representation.
7. Solution of system of linear equations using Gauss-Seidel iteration.
8. Compute eigenvalues and eigenvectors and find the largest and smallest eigenvalue by Rayleigh power method.
9. Solutions of Second-order ordinary differential equations with initial/boundary conditions.
10. Solution of a differential equation of oscillations of a spring/deflection of a beam with different loads.

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

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- VTU EDUSAT Program

IV Semester

22UMAC400	Engineering Mathematics-IV	(2-2-0)3

Contact Hours:39 CIE:50 Marks SEE: 50 Marks Exam Duration:3 Hrs.

Course Learning Objectives (CLOs):

- **Provide** an insight into applications of conformal mapping. Integration of complex functions.
- **Apply** probability distributions in Engineering.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Construct** and use the concepts of analytic function to solve the problems arising in Engineering field.			1,2
CO-2	**Utilize** conformal transformation and complex integral to transform irregular domain onto a relatively simple domain.			1,2
CO-3	**Apply** discrete and continuous probability distributions in analyzing the probability models arising in engineering field.			1,2,12
CO-4	**Estimate** the correlation, covariance using joint probability distributions. **Recite** Markov chains and describe stochastic process.			1,2,12
CO-5	**Use** student's t-distribution, Chi-square distribution as a test of goodness of fit .			1,2,12

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1	1	-	-	-	-	-	-		-	-	1

Pre-requisites: Knowledge of fundamentals of calculus, Basics of statistics and probability theory.

Contents:

Unit-1

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms. Construction of analytic functions: Milne-Thomson method-Problems**.** **8Hrs.**

Unit-2

Conformal transformations:

Introduction. Discussion of conformal transformations:

$\mathbf{w}= e^z; w = z^2, w = z + \frac{1}{z}, z \neq o$. Bilinear transformations- Problems.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's Integral theorem. **8Hrs.**

Unit-3

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, Exponential and normal distributions-problems (No derivation for mean and standard deviation)-Illustrative examples**.** **8Hrs.**

Unit-4

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.

Markov chains– Introduction, probability vectors, Stochastic Matrices, Fixed points and Regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states**.** **8Hrs.**

Unit-5

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **8Hrs.**

Reference Books:

1.**B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017.

2.**E. Kreyszig**: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed.(Reprint), 2016.

3. **PeterV.O'Neil**: Advanced Engineering Mathematics, Internationalstudents edition, 2011.

4. **Kishor S. Trivedi**: Probability& Statistics with Reliability, Queuing, and Computer Science Applications, Prentice-Hall of India, 2005.

5. **N. P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" LaxmiPublications,10th Ed., 2022.

II Semester

22MATE21	Mathematics-2 for Electrical & Electronic Stream	(2-2-2)4

Contact Hours:40 Theory + 12 Lab Sessions

Course Learning Objectives (CLO's):

- **Develop** the knowledge of solving electronics and electrical engineering problems numerically.
- **Familiarize** the importance of Integral calculus and Vector calculus essential for electronics and electrical engineering.
- **Analyse** Electronics and Electrical Engineering problems by applying Partial DifferentialEquations.

Course outcomes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO1	Apply the knowledge of numerical methods in solving physical and engineering phenomena.			1,2,12
CO2	To understand the concept of Laplace transform and to solve initial value problems.			1,2,12
CO3	Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line Integral and surface integral.			1,2,12
CO4	Demonstrate the idea of Linear dependence and independence of sets in the vector space, And linear transformation			1,2,12
CO5	Get familiarize with modern mathematical tools namely SCILAB/PYTHON/MATLAB		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			2							1

Pre- requisites: Knowledge of fundamentals of calculus.

Unit-1 (Numerical methods -1)

Importance of numerical methods for discrete data in the field of EC&EE Engineering Applications.

Solution of algebraic and transcendental equations: Regula-Falsi method and Newton-Raphson method (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.

N**umerical integration**: Trapezoidal, Simpson's $(1/3)^{rd}$and $(3/8)^{th}$rules (without proof). Problems.

S**elf-Study:** Bisection method, Lagrange's inverse Interpolation, Weddle's rule.

Applications: Estimating the approximate roots, extremum values, Area, volume, and surface area. **8 Hrs.**

Unit-2 (Numerical Methods -2)

Introduction to various numerical techniques for handling EC& EE Applications.

Numerical Solution of Ordinary Differential Equations (ODEs):

Numerical solution of ordinary differential equations of first order and first degree - Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor- corrector formula (No derivations of formulae). Problems.

Self-Study: Adam-Bashforth method.

Applications: Estimating the approximate solutions of ODE for electric circuits. **8 Hrs.**

Unit-3 (Laplace Transform)

Importance of Laplace Transform for EC &EE Engineering Applications.

Existence and Uniqueness of Laplace transform (LT), transform of elementary functions, region of convergence, Properties–Linearity, Scaling, t-shift property, s-domain shift, differentiation in the s-domain, division by t, differentiation and integration in the time domain, LT of special functions- periodic functions(square wave, saw-tooth wave, triangular wave, full & half wave rectifier), Heaviside Unit step function, Unit impulse function.

Inverse Laplace Transforms:

Definition, properties, evaluation using different methods, convolution theorem (without proof), problems, and Applications to solve ordinary differential equations.

Self-Study: Verification of convolution theorem.

Applications: Signals and systems, Control systems, LR, CR & LCR circuits. **8 Hrs.**

Unit-4 (Vector Calculus)

Introduction to Vector Calculus in EC&EE Engineering Applications.

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

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

Self-Study: Volume integral and Gauss divergence theorem.

Applications: Conservation of laws, Electrostatics, Analysis of stream lines and electric potentials. **8 Hrs.**

Unit-5 (Vector Space and Linear Transformations)

Importance of Vector Space and Linear Transformations in the field of EC&EE Engineering Applications.

Vector spaces: Definition and examples, subspace, linear span, linearly independent and dependent sets, Basis and dimension.

Linear Transformations: Definition and examples, Algebra of transformations, Matrix of a linear transformation. Change of coordinates, Rank and nullity of a linear operator, Rank-Nullity theorem. Inner product spaces and orthogonality.

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Self-study: Angles and Projections. Rotation, reflection, contraction and expansion.

Applications: Image processing, AI & ML, Graphs and networks, computer graphics.

8 Hrs.

List of Laboratory experiments

(2hours/week per batch/batchstrength15)10 labsessions + 1repetitionclass + 1LabAssessment

1. Solution of algebraic and transcendental equations by Regula-Falsiand Newton-Raphsonmethod.
2. Interpolation/Extrapolation using Newton's forward and backward difference formula.
3. Computation of area under the curve using Trapezoidal, Simpson's(1/3)rd and (3/8)th rule
4. Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
5. Solution of ODE of first order and first degree by Runge-Kutta 4th order and Milne's predictor-corrector method.

6. Computing inverse Laplace transform of standard functions.
7. Laplace transform of convolution of two functions.
8. Finding gradient, divergent, curl and their geometrical interpretation. Verification of Green's theorem.
9. Computation of basic and dimension for a vector space and Graphical representation of linear transformation.
10. Visualization in time and frequency domain of standard functions.

Reference 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. **N.P Bali and Manish Goyal**:"Atext book of Engineering Mathematics" LaxmiPublications,10th Ed., 2022.
4. **Gupta C.B,SingS. Rand Mukesh Kumar**: "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education (India) Pvt. Ltd 2015.
5. **H.K.Dass and Er.Rajnish Verma**: "Higher Engineering Mathematics"S. Chand Publication,3rd Ed., 2014.

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/
- VTUe-Shikshana Program
- VTU EDUSAT Program

I Semester

22MATM11	Mathematics-I for ME Stream	(2:2:2:0)4

Contact Hours:40

Course Learning Objectives (CLO's):

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

Course outcomes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to Pos(1-12)/PSOs (1,2)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-1	Apply the knowledge of calculus to solve problems related to polar curves.	--	--	1,2,12
CO-2	Learn the notionof partial differentiation to computerate of change of multivariate functions.	--	--	1,2,12
CO-3	Analyze the solutionof linear and non-linear ordinary differential equations.	--	--	1,2,12
CO-4	make use of matrix theory for solving for system of linear equations and compute	--	--	1,2,12
CO-5	familiarize with modern mathematical tools namely MATHEMATICA/ MATLAB /PYTHON	--	5	1,2,12

POs/PSO	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Leve	1	1	--	---	2	--	--	--	--	--	--	1

Pre- requisites: Knowledge of fundamentals of calculus.

Course Contents:

Unit-I: (Calculus)

Introduction to polar coordinates and curvature relating to mechanical 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.

Self-study: Center and circle of curvature, evolutes and involutes.
Applications: Applied Mechanics, Strength of Materials, Elasticity.
08Hrs.

Unit-II: (Series Expansion and Multivariable Calculus)

Introduction to series expansion and partial differentiation in the field of Mechanical engineering applications.
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.
Self-study: Euler's theorem and problems. Method of Lagrange's undetermined multipliers with a single constraint.
Applications: Computation of stress and strain, Errors and approximations in Manufacturing process, Estimating the critical points and extreme values, vector calculus. **08Hrs.**

Unit-III: (Ordinary Differential Equations (ODEs) of first order)

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 $\frac{1}{N}\left(\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}\right)$ and $\frac{1}{M}\left(\frac{\partial N}{\partial x}-\frac{\partial M}{\partial y}\right)$. Orthogonal trajectories, Newton's law of cooling. 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: R-L circuits. Solvable for x and y.
Applications: Rate of Growth or Decay, Conduction of heat. **08Hrs.**

Unit-IV: (Linear Algebra)

Introduction of linear algebra related to Mechanical Engineering applications. Elementary row transformation of a matrix, Rank of a matrix. Consistency and solution of a system of linear equations-Gauss-elimination method, Gauss- Jordan method and approximate solution by Gauss-Seidel method. Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant Eigen value and Eigen vector.
Self-Study: Solution of a system of equations by Jacobi's iterative method. Inverse of a square matrix by Cayley-Hamilton theorem. **08Hrs.**

Unit-V: (Ordinary Differential Equations of higher order)

Importance of higher-order ordinary differential equations in Mechanical Engineering applications. Higher-order linear ODEs with constant coefficients - 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. **08Hrs.**

List of Laboratory experiments (2hours/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. Numerical solution of system of linear equations, test for consistency and graphical representation
7. Solution of system of linear equations using Gauss-Seidel iteration
8. Compute eigenvalues and eigenvectors and find the largest and smallest eigenvalue by Rayleigh power method.
9. Solutions of Second-order ordinary differential equations with initial/boundary conditions.
10. Solution of a differential equation of oscillations of a spring/deflection of a beam with different loads

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

Reference Books:

1. **B.S.Grewal**:"HigherEngineeringMathematics",Khannapublishers, 44thEd.,2021.
2. **E.Kreyszig**:"Advanced Engineering Mathematics",John Wiley &Sons, 10thEd.,2018.
3. **V. Ramana**: "Higher Engineering Mathematics" McGraw-Hill Education, 11thEd., 2017.
4. **N.P Bali and Manish Goyal**:"Atext book of Engineering Mathematics" Laxmi Publications, 10thEd.,2022.
5. **H. K. Dass and Er. Rajnish Verma**: "Higher Engineering Mathematics" S. Chand Publication, 3rdEd.,2014.

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- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- VTUe-Shikshana Program
- VTU EDUSAT Program

II Semester

22MATM21	Mathematics-2 for Mechanical Stream	(2-2-2)4

Contact Hours: 40 Theory + 12LabSessions

Course learning objectives (CLO's):

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

Course outcomes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-1	Apply the knowledge of numerical methods in solving physical and engineering phenomena.			1,2,12
CO-2	Apply the knowledge of multiple integrals to compute area and volume.			1,2,12
CO-3	Demonstrate partial differential Equations and their solutions for physical interpretations.			1,2,12
CO-4	Understand the applications of vector calculus refer to solenoidal, irrotational vector field.			1,2,12
CO-5	Get familiarize with modern mathematical tools namely Mathematica/MatLab/Python/Scilab		5	1,2,12

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1	1			2							1

Pre-requisite: Knowledge of fundamentals of calculus.

Unit-1 (Numerical Methods-1)

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 formul a(All formulae without proof). Problems.

Numerical integration:Trapezoidal, Simpson's(1/3)rd and(3/8)th rules(without p roof). Problems.

Self-Study: Bisection method, Lagrange's inverse Interpolation.

Applications: Estimating the approximate roots, extremum values, Area, volume, and surface area. Finding approximate solutions to Mechanical Engineering problems. **8 Hrs.**

Unit-2 (Numerical Methods-2)

Introduction to various numerical techniques for handling Mechanical Engineering applications.

Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree-Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor- corrector formula(No derivations of formulae). Problems.

Self-Study: Adam-Bashforth method.

Applications: Finding approximate solutions to ODE related to mechanical engineering fields. **8 Hrs.**

Unit-3 (Integral Calculus)

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 multiple integral. Problems.

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

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

Applications: Applications to mathematical quantities (Area, Surface area, Volume), Analysis of physical models. **8 Hrs.**

Unit- 4 (Partial Differential Equations) (PDEs)

Importance of partial differential equations for Mechanical Engineering applications.

Formation of PDE's by elimination of arbitrary constants and functions. Solution of non- homogeneous PDE by direct integration. Homogeneous PDEs involving derivatives 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 and wave equation by the method of separation of variables.

Applications: Design of structures (vibration of rod/membrane) **8 Hrs.**

Unit-5 (Vector Calculus)

Introduction to Vector Calculus in Mechanical Engineering applications.

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

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

Self-Study: Volume integral and Gauss divergence theorem.

Applications: Heat and mass transfer, oil refinery problems, environmental engineering. Analysis of streamlines, velocity and acceleration of a moving particle. **8 Hrs.**

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

1. Solution of algebraic and transcendental equations by Regula-Falsi and Newton- Raphson method.
2. Interpolation/Extrapolation using Newton's forward and backward difference formula.
3. Computation of area under the curve using Trapezoidal, Simpson's(1/3)rd and (3/8)th rule Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
4. Solution of ODE of first order and first degree by Runge-Kutta4th order and Milne's predictor-corrector method.
5. Program to compute surface area, volume and centre of gravity.
6. Evaluation of improper integrals.
7. Solution of Lagrange's linear partial differential equations.
8. Finding gradient, divergent, curl and their geometrical interpretation.

9. Verification of Green's theorem.
10. Solution of one-dimensional heat equation and wave equation.

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.P.Bali and Manish Goyal**:"A textbook ofEngineeringMathematics" Laxmi Publications,10th Ed.,2022.
4. **B.S. Grewal**: "Higher Engineering Mathematics", Khannapublishers, 44thEd.,2021.
5. **E. Kreyszig**: "Advanced Engineering Mathematics",JohnWiley &Sons, 10thEd., 2018.

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- http://academicearth.org/
- VTUe-Shikshana Program
- VTU EDUSAT Program

I Semester

22MATS11	Mathematics-1 for CSE	(2-2-2)4

Contact Hours: 40 Theory + 12 Lab Sessions

Course Learning Objectives (CLO's): This course focuses on the following learning perspectives:

- **Familiarize** the importance of calculus associated with one variable and multi-variable for computer science and engineering.
- **Analyze** computer science and engineering problems by applying Ordinary Differential Equations.
- **Develop** the knowledge of Linear Algebra to solve the system of equations.
- **Apply** the knowledge of modular arithmetic to computer algorithms.

Course Out comes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/PSOs(13-16)**		
		Substantial Level(3)	**Moderate Level(2)**	**Slight Level(1)**
CO-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.	-	-	1,2,12
CO-2	Analyze the solution of linear and nonlinear ordinary differential equations.	-	-	1,2,12
CO-3	Make use of matrix theory for solving system of linear equations and compute Eigen values and Eigen vectors.	-	1,2	
CO-4	Get acquainted and apply modular arithmetic to computer algorithms.	-	-	1,2,12
CO-5	Familiarize with modern mathematical tools namely MATHEMATICA / MATLAB / PYTHON/SCILAB.	-	5	1,2,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1.2	1.2	-	-	1	-	-	-	-	-	-	1.0

Pre-requisite: Knowledge of fundamentals of calculus.

Contents

Unit-1(Calculus)

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.

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

Applications: Computer graphics, Image processing. **8Hrs.**

Unit-2 (Series Expansion and Multi variable Calculus)

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.

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

Applications: Series expansion in computer programming, Errors and approximations. **8Hrs.**

Unit-3 (Ordinary Differential Equations (ODE) of first Order)

Linear and Bernoulli's differential equations. Exact and reducible to exact differential equations-Integrating factors on $\frac{1}{N}\left(\frac{\partial N}{\partial x}-\frac{\partial M}{\partial y}\right)$ *and* $\frac{1}{M}\left(\frac{\partial N}{\partial x}-\frac{\partial M}{\partial y}\right)$-Orthogonal trajectories(cartesian form) , LR- circuits.

Problems Non-linear differential equations: Introduction to general and singular solutions, Solvable for p only, Clairaut's equations. Problems.

Self-Study: Applications of ODE"s , Solvable for x and y.

Applications of ordinary differential equations: Rate of Growth or Decay, RC circuits. **8 Hrs.**

Unit-4 Linear Algebra

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 Eigenvectors, Raleigh's power method to find the dominant Eigen value and Eigen vector. Problems.

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

Applications: Boolean matrix, Network Analysis, Markov Analysis, Critical point of a net work system. Optimum solution. **8 Hrs.**

Unit-5 Modular Arithmetic:

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. Applications of Congruences-RS Algorithm.

Self-Study: Divisibility, GCD, Properties of Prime Numbers, Fundamental theorem of Arithmetic.
Applications: Cryptography, encoding and decoding, RS Applications in public key encryption. **8 Hrs.**

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

10 lab sessions+ 1repetitionclass+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 Numerical solution of system of linear equations, test for consistency and graphical representation.
7 Solution of system of line are equations using Gauss- Seidel iteration
8 Compute eigen values and eigen vectors and find the largest and smallest eigen value by Rayleigh power method.
9 Finding GCD using Euclid's Algorithm
10 Applications of Wilson's theorem

Suggested softwares: Mathematica/MatLab/Python/Scilab

Reference Books:

1. **B. S. Grewal**:"Higher Engineering Mathematics", Hanna publishers,44th Ed., 2021.
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10th Ed.,2018.
3. **V.Ramana**: "Higher Engineering Mathematics" McGraw-HillEducation,11th Ed.2017.
4. **Srimanta Pal &SubodhC. Bhunia**: "Engineering Mathematics"Oxford UniversityPress,3rd Ed.,2016.
5. **N.P Bali and Manish Goyal**:"A text book of Engineering Mathematics Laxmi Publications,10th Ed.,2022.

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- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- VTU e-Shikshana Program
- VTU EDUSAT Program

II Semester

22MATS21	Mathematics-2 for CSE	(2-2-2)4

Contact Hours: 40 Theory + 12 Lab Sessions

Course Learning Objectives (CLO's): This course focuses on the following learning perspectives:

- Develop the knowledge of numerical methods and apply them to solve transcendental and differential equations.
- Familiarize the importance of Integral calculus and Vector calculus.
- Learn vector spaces and linear transformations.

Course Outcomes (CO's):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/PSOs (13-16)		
		Substantial Level(3)	Moderate Level(2)	Slight Level(1)
CO-1	Apply the knowledge of numerical methods in analysing the discrete data and solving the physical and engineering problems.	-	-	1,2,12
CO-2	Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing area and volume.	-	-	1,2,12
CO-3	Understand the applications of vector calculus refer to solenoidal, and irrotational vectors, Orthogonal curvilinear coordinates.	-	-	1,2,12
CO-4	Demonstrate the idea of Linear dependence and independence of sets in the vector space, and linear transformation	-	-	1,2,12
CO-5	Get familiarize with modern mathematical tools namely MATHEMATICA/MATLAB/PYTHON / SCILAB	-	5	1,2,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Mapping Leve	1	1	-	-	5	-	-	-	-	-	-		-	-	-	-

Pre-requisites: Knowledge of fundamentals of calculus.

Course Contents:

Unit-1: (Numerical Methods–1)

Numerical methods: 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, Newtons 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.

Applications: Estimating the approximate roots, extremum values, Area, volume and surface area. Errors infinite precision. **8Hrs.**

Unit-2: (Numerical Methods–2)

Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree – Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations of formulae).Problems.

Self-Study:Adam-Bashforth method.

Applications: Estimating the approximate solutions of ODE. **8Hrs**.

Unit-3: (Integral Calculus)

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 multiple integral. Problems.

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

Self-Study: Center of gravity, Duplication formula.

Applications: Antenna and wave propagation, Calculation of optimum value in various geometries. Analysis of physical models. **8Hrs**.

Unit-4: (Vector Calculus)

Introduction to Vector Calculus in Computer Science & Engineering: Scalar and vector fields. Gradient, directional derivative, curl and divergence – physical interpretation, solenoidal and irrotational vector fields. Problems.

Curvilinear coordinates: Scale factors, base vectors, Cylindrical polar coordinates, Spherical polar coordinates, transformation between cartesian and curvilinear systems, orthogonally. Problems.

Self-Study: Volume integral.

Applications: Conservation of laws, Electrostatics, Analysis of stream lines. **8Hrs**.

Unit-5: (Vector Spaces and Linear Transformations)

Vector spaces: Definition and examples, subspace, linear span, linearly independent and dependent sets, Basis and dimension. Problems.

Linear transformations: Definition and examples, Algebra of transformations, Matrix of a linear transformation. Change of coordinates, Rank and nullity of a linear operator, rank-nullity theorem. Inner-product spaces and orthogonality. Problems.

Self-study: Angles and Projections. Rotation, reflection, contraction and expansion.

Applications: Image processing, AI&ML, Graphs and networks, computer graphics. **8Hrs.**

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

1. Solution of algebraic and transcendental equations by Ramanujan's, Regula- Falsi and Newton-Raphson method.
2. Interpolation/Extrapolation using Newton's forward and back ward difference Formula.
3. Computation of area under the curve using Trapezoidal, Simpson's (1/3)rd and(3/8)th rule.
4. Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method.
5. Solution of ODE of first order and first degree by Runge-Kutta 4^{th} order and Milne's predictor-corrector method.
6. Program to compute area, surface area, volume and centre of gravity.
7. Evaluation of improper integrals.
8. Finding gradient, divergent, curl and their geometrical interpretation.
9. Computation of basis and dimension for a vector space and Graphical representation of lineart transformation.
10. Computing the inner product and orthogonality.

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

Reference 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. **V. Ramana**: "Higher Engineering Mathematics" McGraw-Hil Education, 11th Ed.2017
4. **N.P Bali and Manish Goyal**: "A text book of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
5. **David C. Lay**: "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.

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/
- VTU e-Shikshana Program
- VTU EDUSAT Program.

III Semester

22UMAC300	Engineering Mathematics-III	(2- 2 - 0)3

Contact Hours:39 CIE:50 Marks SEE: 50 Marks Exam Duration:3 Hrs.

Course Learning Objectives (CLOs):

To have an insight into Fourier series, Fourier transforms, Z-transforms. To solve linear and Non-linear programming problems and use statistical tools to problems arising in engineering applications using numerical methods.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Express** periodic function as a Fourier series and obtain the various harmonics of the Fourier series expansion for the given numerical data.			1,2
CO-2	**Transform** the given function using Fourier transforms depending on the nature of engineering applications. **Apply** Z-transform for series of mathematical conversion to mathematical framework used as digital filter. **Solve** difference equations using Z-transform.			1,2
CO-3	**Obtain** series solution of ordinary differential equations.			1,2
CO-4	**Make** use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.		1,2,12	
CO-5	**Formulate** LPP and **obtain** optimal solutions using different tools.		1,2,12	

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1.4	1.4										2

Pre-requisites: Knowledge of fundamentals of calculus, Statistical averages

Contents:

Unit-1

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions of period 2π and arbitrary period. Half- range Fourier series. Practical harmonic analysis, examples from engineering field. **8 Hrs.**

Unit-2

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms.(Simple problems).

Z-Transforms and Difference Equations : Z-transform- definition, Standard Z-transforms, Damping and shifting rules, Initial value and Final value theorems (without proof) problems. Inverse Z-transform. Simple problems. Difference equations-basic definition. Application of Z-transform to solve Difference equations. **9Hrs.**

Unit-3

Special functions: Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind, Recurrence relations, Generating function of Bessel's functions , orthogonality of Bessel's function. **8 Hrs.**

Unit-4

Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form $= \boldsymbol{ax + b; y = ax^2 + bx + c; y = ax^b}$..

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation -problems. Regression analysis- lines of regression–problems. **7 Hrs.**

Unit-V

Linear and Non-Linear programming: Introduction, Mathematical formulation of a L.P.P, basic solution. Geometric (or graphical) method, Simplex method.

Non Linear Programming – Constrained extremal problems-Lagrange's multiplier method. **7 Hrs.**

Reference Books:

1 **B.S.Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44thEd., 2017.

2. **E.Kreyszig**: Advanced Engineering Mathematics, John Wiley &Sons, 10th Ed.(Reprint).2016.

3. **Srimanta Pal et al**: Engineering Mathematics, Oxford University Press, 3rd Edition, 2016.

4. **B. V. Ramana**:"HigherEngineering Mathematics" 11thEdition, Tata McGraw-Hill, 2010.

5. **Er.Prem Kumar Gupta, Dr.D.S.Hira,** "Operation Research " S.Chand & Company Pvt.Ltd. 7th edition, 2014.

22UMBA401	Mathematics	(3 -0 -0)

Contact Hours: 39 Hrs.

Course Learning Objectives (CLOs):

This course will enable students to use Laplace transform to solve differential equations. Analyze and Solve system of linear equation. Understand the concept of vector differentiation and vector integration.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Transform** the given function using Laplace transforms and study their properties.	-	-	1,2
CO-2	**Apply** Laplace transform to solve differential equations.	-	-	1,2
CO-3	**Compute** the solution of system of equations. Evaluate Eigen values and Eigen vectors for a matrix.	-	1,2	
CO-4	**Study** vector calculus and **compute** gradient, divergence, curl of a single valued function**.**	-		1,2
CO-5	**Study** vector integration and **evaluate** Line integrals, Surface integrals and Volume integrals	-		1,2

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1.2	1.2	-	-	-	-	-	-		-	-	-

Pre-requisites: Knowledge of fundamentals of calculus, Basic Linear Algebra

Course Content:

Unit-1

LaplaceTransforms:

Definition and Properties. Laplace transform of elementary functions. Laplace transform of $e^{at}f(t)$ Laplace transform of $t^n f(t)$, Laplace transform of $\frac{f(t)}{t}$, Laplace transforms of Periodic functions and unit-step function–problems.**8 Hrs.**

Unit-2

Inverse Laplace Transforms

Inverse Laplace transform -problems with standard, Convolution theorem (without proof) to find the inverse Laplace transform and problems. Solution of linear differential equations using Laplace transform. **8 Hrs.** .

Unit-3

Elementary Linear Algebra:

Rank of a matrix - Row Echelon form. Test for consistency for system of linear equations. Solution of system of linear equations – Gauss-elimination method (consistency), Gauss-Seidel iterative method. Eigen values and Eigen vectors-Rayleigh's power method. **8 Hrs.**

Unit-4

Vector Calculus:-

Vector Differentiation: Scalar point function and vector point functions. Gradient, Directional Derivative; Curl and Divergence-physical interpretation. Solenoidal and irrotational vectors. Illustrative problems. **8 Hrs.**

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Unit-5

Vector Integration:

Line integrals, Surface integrals and Volume integrals. Green's theorem, Gauss divergence theorem and Stoke's theorem (only statements). **7 Hrs**.

Text Books

1. **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44thedition, 2017.
2. **Rajesh Verma &H.K.Dass,** Higher Engineering Mathematics,,3rd edition. 2014.

Note: 1. Grades (i) PP (ii) NP
2. No semester End Examination
3. Audit (Bridge course)

1.The mandatory non–credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.

2. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

22UMBA301	Mathematics	(3-0 -0)

Contact Hours: 39 Hrs.

Course Learning Objectives (CLOs):

This course will enable students to master the basic tools of differential & integral calculus, differential equations and partial differential equations and become skilled to formulate, solve and analyze science and engineering problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Apply** the knowledge of calculus to solve problems related to polar curves, curvature and its applications in determining the bentness of a curve.	-	-	1,2
CO-2	**Solve** multiple integration and use Beta and Gamma function to solve definite integrals	-	1,2	
CO-3	**Solve** first order linear differential equations analytically using standard methods.	-	1,2	
CO-4	**Solve** higher order differential equations with constant co-efficients and variable co-efficients.	-	1,2	-
CO-5	**Learn** partial differentiation to calculate rates of change of multivariate functions. Solve problems related to composite functions and Jacobians. Solve problems on partial differential equations by method of separation of variables.	-		1,2

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1.6	1.6	-	-	-	-	-	-		-	-	-

Pre-requisites : Knowledge of fundamentals of calculus.

Course Content:

Unit-1

Differential Calculus: n^{th} order differentiation of standard functions. Leibnitz theorem (Statement only & illustrative examples), Taylor's series for single variable (Statement only & illustrative examples), Maclaurin's series for single variable (Statement only & illustrative examples).

Polar curves-angle between the radius vector and tangent (Formula & illustrative examples), angle between two curves (Formula & illustrative examples). Definition of Curvature and radius of curvature.-Radius of curvature for Cartesian and polar curves (Formulas & illustrative examples) **10 Hrs.**

Unit-2

Integral Calculus: Reduction formula for $\int_0^{\pi/2} sin^n\, xdx, \int_0^{\pi/2} cos^n\, xdx$ and $\int_0^{\pi/2} sin^n\, x cos^m x dx$(Formula &illustrative examples). Definition of Beta and Gamma functions (illustrative examples).Relation between Beta and Gamma functions (No Proof) (illustrative examples).Evaluation of Double integral (direct and region given), Change of variables. Evaluation of Triple integral (direct examples). **10 Hrs.**

Unit-3

Ordinary Differential Equations of first order:-

Libnitz's Linear differential equation, Bernoulli's differential equation, Exact differential equations. Orthogonal trajectories. **5 Hrs**.

Unit-4

Differential Equations of higher order

Solution of Second order Linear ordinary differential equation with constant coefficients. Method of variation of parameters. Legendre's homogeneous equations. **8 Hrs.**

Unit-5

Partial Differentiation:

Definition of Partial derivative (illustrative examples), Total differentiation (illustrative examples), Differentiation of Composite functions (illustrative examples).Jacobians and its properties (No Proof) (illustrative examples).

Partial Differential Equations (PDE's):

Formation of PDE's by elimination of arbitrary constants /functions. Solution of PDE by variable separable method. **6 Hrs.**

Text Books

1. **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44th edition,2017.
2. **H.K.Dass&RajnishVerma**,Higher Engineering Mathematics,3rd edition, 2014.

Note: 1. Grades (i) PP (ii) NP
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3. Audit (Bridge course).

1. The mandatory non – credit courses Mathematics for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.
2. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.