Mathematics for Civil Engineering Stream-II

Course Code	**22MATC21**	**Course type**	Integrated	**Credits L-T-P**	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	**Familiarize** the importance of Integral calculus and Vector calculus essential for civil
2.	Engineering.
3.	**Analyze** Civil engineering problems applying Partial Differential Equations.
4.	**Develop** the knowledge of solving civil engineering problems numerically.

Required Knowledge of : Basic Trigonometry, Calculus, Algebra, Matrices, I Semester knowledge

Unit – I	**Contact Hours = 8 Hours**

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

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

(RBT Levels: L1, L2 and L3)

Unit – II	**Contact Hours = 8 Hours**

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.

Applications: Heat and mass transfer, oil refinery problems, environmental engineering. Analysis of stream lines, velocity and acceleration of a moving particle.

(RBT Levels: L1, L2 and L3)

Unit – III	Contact Hours = 8 Hours

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.
Applications: Estimating the approximate roots, extremumvalues, Area, volume, surface area.Finding approximate solutions to civil engineering problems.
(RBT Levels: L1, L2 and L3)

Unit –IV	Contact Hours = 8 Hours

Introduction to various numerical techniques for handling Civil 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.
Applications: Finding approximate solutions to ODE related to civil engineering fields.
(RBT Levels: L1, L2 and L3)

Unit –V	Contact Hours = 8 Hours

Importance of partial differential equations for Civil 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.
Applications: Design of structures (vibration of rod/membrane)
(RBT Levels: L1, L2 and L3)

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Program to compute surface area, volume and centre of gravity
1	2	Evaluation of improper integrals

2	3	Finding gradient, divergent, curl and their geometrical interpretation
2	4	Verification of Green's theorem
5	5	Solution of one-dimensional heat equation and wave equation
3	6	Solution of algebraic and transcendental equations by Regula-Falsi and Newton- Raphson method
3	7	Interpolation/Extrapolation using Newton's forward and backward differenceformula
3	8	Computation of area under the curve using Trapezoidal, Simpson's $(1/3)^{rd}$and $(3/8)^{th}$rule
4	9	Solution of ODE of first order and first degree by Taylor's series and Modified Euler method
4	10	Solution of ODE of first order and first degree by Runge-Kutta 4^{th}order and Milne's predictor-corrector method

Unit No.	Self-Study Topics
1	Volume by triple integration, Centre of gravity.
2	Volume integral and Gauss divergence theorem.
3	Bisection method, Lagrange's inverse Interpolation
4	Adam-Bashforth method
5	Solution of one-dimensional heat equation and wave equation by the method of Separation of variables

Books	
	Text Books:
1	**B. S. Grewal**: "Higher Engineering Mathematics" Khanna publishers, 44^{th} Ed., 2021.
2	**E. Kreyszig**: "Advanced Engineering Mathematics" John Wiley & Sons, 10^{th} Ed., 2018.
	Reference Books:
1	**V. Ramana:** "Higher Engineering Mathematics"McGraw-Hill Education, 11^{th} Ed., 2017
2	**Srimanta Pal & Subodh C. Bhunia**: "Engineering Mathematics"Oxford University Press, 3^{rd} Ed., 2016.
3	**N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics"Laxmi Publications, 10^{th} Ed., 2022.
4	**C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics"McGraw –HillBook Co., Newyork, 6^{th} Ed., 2017.
5	**Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education(India) Pvt. Ltd 2015.

6	**H. K. Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics"S. Chand Publication, 3rd Ed., 2014.
7	**James Stewart: "**Calculus"Cengage Publications, 7th Ed., 2019.
8	**David C Lay:** "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018
9	**Gareth Williams:** "Linear Algebra with applications", Jones Bartlett Publishers Inc., 6thEd., 2017.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018
2	https://www.youtube.com/watch?v=TWAN_T66Cps&list=PLq-Gm0yRYwTguDcfylj1ZicXxzdZCAr5S&ab_channel=NumericalMethods
3	https://www.youtube.com/watch?v=zT83sJ5IrEE&list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO&ab_channel=nptelhrd
4	https://www.youtube.com/watch?v=p8u0Fc63OYg&list=PLOzRYVm0a65eWglxWw5WzQLrlG2EaiTIi&index=24&ab_channel=IITBombayJuly2018
5	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply the knowledge of multiple integrals to compute area and volume and Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line integral and surface integral.	L1, L2 and L3	1	
2.	Apply the knowledge of numerical methods in analyzing the discrete data and for solving the physical and engineering problems.	L1, L2 and L3	1	
3.	Demonstrate partial differential equations and their solutions for physical interpretations.	L1, L2 and L3	1	
4.	Familiarize with modern mathematical tool namely MATLAB	L1, L2 and L3	5	

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 10 marks

Lab test: (Batch wise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting two experiments and writing report: 5x 2 =10 marks
4. Calculations, results, graph and conclusion for two experiments : 5x 2 =10 marks
5. Viva voce:05 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**

4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A(30 marks),B(50 marks) and C (20 marks).** 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

Rubrics:

Levels	**Target**
1(Low)	
2(Medium)	
3(High)	

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓														
2	✓														
3	✓														
4					✓										
5															
6															
Tick mark the CO, PO and PSO mapping															

Mathematics for CSE/ISE Stream-II

Course Code	22MATS21	Course type	Integrated	Credits L-T-P	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	**Familiarize** the importance of Integral calculus and Vector calculus essential
2.	**Learn** vector spaces and linear transformations**.**
3.	**Develop** the knowledge of numerical method and apply to solve transcendental and Differential equations.

Required Knowledge of : Basic Trigonometry, Calculus, Algebra, Matrices, I Semester knowledge

Unit – I	Contact Hours = 8 Hours

Introduction to Integral Calculus in Computer Science/IS& Engineering.
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.
Applications: Antenna and wave propagation, Calculation of optimum value in various geometries.Analysis of probabilistic models.**(RBT Levels: L1, L2 and L3)**

Unit – II	Contact Hours = 8 Hours

Introduction to Vector Calculus in Computer Science/IS& 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, orthogonality. Problems.
Applications: Conservation of laws, Electrostatics, Analysis of stream lines.
(RBT Levels: L1, L2 and L3)

Unit – III	Contact Hours = 8 Hours

Importance of numerical methods for discrete data in the field of Computer Science/IS& 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.

Applications: Estimating the approximate roots, extremum values, Area, volume, surface area. Errors in finite precision.**(RBT Levels: L1, L2 and L3)**

Unit –IV	Contact Hours = 8 Hours

Introduction to various numerical techniques for handling Computer Science/IS& 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.

Applications: Estimating the approximate solutions of ODE.**(RBT Levels: L1, L2 and L3).**

Unit –V	Contact Hours = 8 Hours

Importance of Vector Space and Linear Transformations in the field of Computer Science/IS & Engineering.

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.

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

(RBT Levels: L1, L2 and L3)

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Program to compute area, surface area, volume and centre of gravity
1	2	Evaluation of improper integrals
2	3	Finding gradient, divergent, curl and their geometrical interpretation

5	4	Computation of basis and dimension for a vector space and Graphical representation of linear transformation.
5	5	Computing the inner product and orthogonality
3	6	Solution of algebraic and transcendental equation by Ramanujan′s, Regula-Falsi and Newton-Raphson method
3	7	Interpolation/Extrapolation using Newton′s forward and backward difference formula
3	8	Computation of area under the curve using Trapezoidal, Simpson's $(1/3)^{rd}$and $(3/8)^{th}$rule
4	9	Solution of ODE of first order and first degree by Taylor′s series and Modified Euler's method
4	10	Solution of ODE of first order and first degree by Runge-Kutta 4th order and Milne's predictor-corrector method

Unit No.	Self-Study Topics
1	Center of gravity, Duplication formula.
2	Volume integral.
3	Ramanujan's method, Bisection method, Lagrange's inverse Interpolation, Weddle's rule.
4	Adam-Bashforth method.
5	Angles and Projections. Rotation, reflection, contraction and expansion

Books	
	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.
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1	https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018
2	https://www.youtube.com/watch?v=TWAN_T66Cps&list=PLq-Gm0yRYwTguDcfylj1ZicXxzdZCAr5S&ab_channel=NumericalMethods
3	https://www.youtube.com/watch?v=zT83sJ5IrEE&list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO&ab_channel=nptelhrd
4	https://www.youtube.com/watch?v=LJ-LoJhbBA4&list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7&ab_channel=nptelhrd
5	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Apply the knowledge of multiple integrals to compute area and volume and Understand the applications of vector calculus refer to solenoidal, irrotational vectors, orthogonal curvilinear coordinates.	L1, L2 and L3	1	
2.	Apply the knowledge of numerical methods in analyzing the discrete data and for solving the physical and engineering problems.	L1, L2 and L3	1	
3.	Demonstrate the idea of Linear dependence and independence of sets in the vector space,and linear transformation.	L1, L2 and L3	1	
4.	Familiarize with modern mathematical tool namely MATLAB	L1, L2 and L3	5	

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			LAB (40 marks)		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 10 marks

Lab test: (Batch wise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting two experiments and writing report: 5x 2 =10 marks
4. Calculations, results, graph and conclusion for two experiments : 5x 2 =10 marks
5. Viva voce:05 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

THEORY (60 marks)			LAB (40 marks)		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A(30 marks),B(50 marks) and C (20 marks).** 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

Rubrics:

Levels	Target
1(Low)	
2(Medium)	
3(High)	

CO-PO Mapping (planned)													CO-PSO Mapping(planned)		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓														
2	✓														
3	✓														
4					✓										
5															
6															
Tick mark the CO, PO and PSO mapping															

Mathematics for EEE Stream-II

Course Code	22MATE21	Course type	Integrated	Credits L-T-P	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			Total credits	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 20 Hrs Total = 60 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	**Familiarize** the importance of Integral calculus and Vector calculus essential for Electronics and Electrical Engineering
2.	**Analyze** Electronics and Electrical engineering problems applying Partial Differential Equations
3.	**Develop** the knowledge of solving Electronics and Electrical Engineering problems numerically

Required Knowledge of : Basic Trigonometry, Calculus, Algebra, Matrices, I Semester knowledge

Unit – I	Contact Hours = 8 Hours
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. **Applications:** Conservation of laws, Electrostatics, Analysis of stream lines and electric potentials.**(RBT Levels: L1, L2 and L3)**	

Unit – II	Contact Hours = 8 Hours
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. **Applications**: Image processing, AI & ML, Graphs and networks, computer graphics. **(RBT Levels: L1, L2 and L3)**	

Unit – III	Contact Hours = 8 Hours

Importance of numerical methods for discrete data in the field of EC & EE engineering applications.

Solution of polynomial 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.

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

Applications: Estimating the approximate roots, extremum values, Area, volume, surface area.**(RBT Levels: L1, L2 and L3)**

Unit –IV	Contact Hours = 8 Hours

Introduction to various numerical techniques for handling EC & EE 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.

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

(RBT Levels: L1, L2 and L3)

Unit –V	Contact Hours = 8 Hours

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 sdomain,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.

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

(RBT Levels: L1, L2 and L3)

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Finding gradient, divergent, curl and their geometrical interpretation and Verification of Green′s theorem
2	2	Computation of basis and dimension for a vector space and Graphical representation of linear transformation
5	3	Visualization in time and frequency domain of standard functions
5	4	Computing inverse Laplace transform of standard functions
5	5	Laplace transform of convolution of two functions
3	6	Computing the approximate roots for algebraic and transcendental equation
3	7	Interpolation/Extrapolation using Newton′s forward and backward difference formula
3	8	Computation of area under the curve using Trapezoidal, Simpson's $(1/3)^{rd}$ and $(3/8)^{th}$ rule
4	9	Solution of ODE of first order and first degree by Taylor′s series and Modified Euler's method
4	10	Solution of ODE of first order and first degree by Runge-Kutta 4_{th} order and Milne's predictor-corrector method

Unit No.	Self-Study Topics
1	Volume integral and Gauss divergence theorem.
2	Angles and Projections. Rotation, reflection, contraction and expansion
3	Verification of convolution theorem.
4	Bisection method, Lagrange's inverse Interpolation, Weddle's rule
5	Adam-Bashforth method

Books	
	Text Books:
1	**B. S. Grewal**: "Higher Engineering Mathematics" Khanna publishers, 44_{th} Ed., 2021.
2	**E. Kreyszig**: "Advanced Engineering Mathematics" John Wiley & Sons, 10_{th} Ed., 2018.
	Reference Books:

1	**V. Ramana:** ″Higher Engineering Mathematics″McGraw-Hill Education, 11th Ed., 2017
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4	**C. Ray Wylie, Louis C. Barrett:** ″Advanced Engineering Mathematics″McGraw −HillBook Co., Newyork, 6th Ed., 2017.
5	**Gupta C.B, Sing S.R and Mukesh Kumar:** ″Engineering Mathematic for Semester I andII″, Mc-Graw Hill Education(India) Pvt. Ltd 2015.
6	**H. K. Dass and Er. Rajnish Verma:** ″Higher Engineering Mathematics″S. Chand Publication, 3rd Ed., 2014.
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	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018
2	https://www.youtube.com/watch?v=TWAN_T66Cps&list=PLq-Gm0yRYwTguDcfylj1ZicXxzdZCAr5S&ab_channel=NumericalMethods
3	https://www.youtube.com/watch?v=zT83sJ5IrEE&list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO&ab_channel=nptelhrd
4	https://www.youtube.com/watch?v=d7NF-_8vVv4&list=PLyqSpQzTE6M8gnapvdLN92hs_4F75OSuH&index=1&ab_channel=NPTEL-NOCIITM

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line integral and surface integral and Demonstrate the idea of Linear dependence and independence of sets in the vector space,and linear	L1, L2 and L3	1	

	transformation			
2.	Apply the knowledge numerical methods in analyzing discrete data and solving physical and engineering phenomena.	L1, L2 and L3	1	
3.	To understand the concept of Laplace transform and to solve initial value problems	L1, L2 and L3	1	
4.	Get familiarize with modern mathematical tools namely MATLAB	L1, L2 and L3	5	

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 10 marks					
Lab test: (Batch wise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting two experiments and writing report: 5x 2 =10 marks 4. Calculations, results, graph and conclusion for two experiments : 5x 2 =10 marks 5. Viva voce:05 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					
THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
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IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					

Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.
3.	Question paper contains three parts **A(30 marks),B(50 marks) and C (20 marks).** 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

Rubrics:

Levels	Target
1(Low)	
2(Medium)	
3(High)	

CO-PO Mapping (planned)													**CO-PSO Mapping(planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓														
2	✓														
3	✓														
4					✓										
5															
6															
Tick mark the CO, PO and PSO mapping															

Mathematics for ME/AE Engineering Stream-II

Course Code	**22MATM21**	**Course type**	**integrated**	**Credits L-T-P**	3 - 0- 1
Hours/week: L-T-P	3 - 0 – 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	**Familiarize** the importance of Integral calculus and Vector calculus essential for ME/AE Engineering.
2.	**Analyze** ME/AE Engineering problems applying Partial Differential Equations.
3.	**Develop** the knowledge of solving ME/AE Engineering problems numerically.
4.	**Familiarize** the importance of Integral calculus and Vector calculus essential for ME/AE Engineering.

Required Knowledge of : Basic Trigonometry, Calculus, Algebra, Matrices, I Semester knowledge

Unit – I	**Contact Hours = 8 Hours**

Introduction to Integral Calculus in ME/AE 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.
Applications: Applications to mathematical quantities (Area, Surface area, Volume), Analysis of probabilistic models.**(RBT Levels: L1, L2 and L3)**

Unit – II	**Contact Hours = 8 Hours**

Introduction to Vector Calculus in ME/AE 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
Applications: Heat and mass transfer, oil refinery problems, environmental engineering. Analysis of stream lines, velocity and acceleration of a moving particle.
(RBT Levels: L1, L2 and L3)

Unit – III	Contact Hours = 8 Hours

Importance of numerical methods for discrete data in the field of ME/AEEngineering. 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.

Applications: Finding approximate solutions to solve ME/AE engineering problems involving numerical data.**(RBT Levels: L1, L2 and L3)**

Unit –IV	Contact Hours = 8 Hours

Introduction to various numerical techniques for handling ME/AE 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.

Applications: Finding approximate solutions to ODE related to ME/AE engineering fields.

Unit –V	Contact Hours = 8 Hours

Importance of partial differential equations for ME/AE 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 the one dimensional heat equation and wave equation

Applications: Vibration of a rod/membrane.**(RBT Levels: L1, L2 and L3)**

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	1	Program to compute surface area, volume and centre of gravity
1	2	Evaluation of improper integrals
2	3	Finding gradient, divergent, curl and their geometrical interpretation
2	4	Verification of Green's theorem
5	5	Solution of one-dimensional heat equation and wave equation
3	6	Solution of algebraic and transcendental equations by Regula-Falsi and

		Newton-Raphson method
3	7	Interpolation/Extrapolation using Newton's forward and backward difference formula
3	8	Computation of area under the curve using Trapezoidal, Simpson's $(1/3)^{rd}$and $(3/8)^{th}$rule
4	9	Solution of ODE of first order and first degree by Taylor's series and Modified Euler's method
4	10	Solution of ODE of first order and first degree by Runge-Kutta 4^{th}order and Milne's method

Unit No.	Self-Study Topics
1	Volume by triple integration, Centre of gravity.
2	Volume integral and Gauss divergence theorem.
3	Bisection method, Lagrange′s inverse Interpolation, Weddle's rule.
4	Adam-Bashforth method
5	Solution of one-dimensional heat equation and wave equation by the method of Separation of variables

Books	
	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, 3rd Ed., 2016.
3	**N.P Bali and Manish Goyal**: ″A textbook of Engineering Mathematics"Laxmi Publications, 10th Ed., 2022.
4	**C. Ray Wylie, Louis C. Barrett:** ″Advanced Engineering Mathematics″McGraw –HillBook Co., Newyork, 6th Ed., 2017.
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2	https://www.youtube.com/watch?v=TWAN_T66Cps&list=PLq-Gm0yRYwTguDcfylj1ZicXxzdZCAr5S&ab_channel=NumericalMethods
3	https://www.youtube.com/watch?v=zT83sJ5IrEE&list=PLyqSpQzTE6M-QT7PvEBHV0iNMvZk9mocO&ab_channel=nptelhrd
4	https://www.youtube.com/watch?v=p8u0Fc63OYg&list=PLOzRYVm0a65eWglxWw5WzQLrlG2EaiTIi&index=24&ab_channel=IITBombayJuly2018

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At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Apply the knowledge of multiple integrals to compute area and volume and Understand the applications of vector calculus refer to solenoidal, irrotational vectors, line integral and surface integral.	L1, L2 and L3	1	
2.	Apply the knowledge of numerical methods in analyzing the discrete data and for solving the physical and engineering problems.	L1, L2 and L3	1	
3.	Demonstrate partial differential equations and their solutions for physical interpretations.	L1, L2 and L3	1	
4.	Familiarize with modern mathematical tool namely MATLAB	L1, L2 and L3	5	

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1	✓														
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3	✓														
4					✓										
5															
6															
Tick mark the CO, PO and PSO mapping															