Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

I Semester:

Course Title	**Mathematics-I (Differential Calculus, Differential Equations and Linear Algebra)**							
Course Code	**22MAU101A**							
Category	**ASC (Applied Science Course)**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	02	00	04	40	20	04
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**				

COURSE LEARNING OBJECTIVES

1. **Familiarize** the importance of calculus associated with one variable and two variables.
2. **Analyze** Engineering problems by applying Ordinary Differential Equations.
3. **Develop** the knowledge of Linear Algebra to solve system of equation by using matrices.
4. **Apply** the knowledge of curvature, partial differentiation, ordinary differential equations and linear algebra in various fields of civil engineering.

Unit	Syllabus content	No. of hours	
		Theory	**Tutorial**
I	**Differential Calculus** **Introduction to polar coordinates and curvature relating to to Civil Engineering.** Polar coordinates, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and Radius of curvature - Cartesian, Parametric, Polar and Pedal forms (without proof). **Self-study:** Centre and circle of curvature, evolutes and involutes. **Applications:** Tracing of polar curves **(RBT Levels: L1, L2 and L3)**	04	04
II	**Series Expansion and Multivariable Calculus** **Introduction to series expansion and partial differentiation in the field of Civil Engineering.** Taylor's and Maclaurin's series expansion for one variable (Statement only). Partial differentiation, Euler's theorem, total derivative- differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables. **Self- study:** Extended Euler's theorem and problems, Method of Lagrange's undetermined multipliers with single constraint. **Applications:** Solution of ODE arises in the field of Civil engineering using Taylor's series method. **(RBT Levels: L1, L2 and L3)**	04	04

III	**Ordinary Differential Equations-I** **Introduction to ordinary differential equations pertaining to the applications for Civil Engineering.** First order exact and reducible to exact differential equations. Higher order linear differential equations with constant coefficient-homogeneous and nonhomogeneous, inverse differential operator. **Self-Study:** First order linear and Bernoulli's differential equations. **Applications of ordinary differential equations:** Orthogonal trajectories. **(RBT Levels: L1, L2 and L3)**	04	04
IV	**Ordinary Differential Equations-II** **Introduction to higher ordinary differential equations pertaining to the applications for Civil Engineering.** Method of variation of parameters, Cauchy's and Legendre's differential equations. Simultaneous differential equations. **Self-Study:** Method of undetermined multiplier for second order equations. **Applications:** Transmission lines. **(RBT Levels: L1, L2 and L3)**	04	04
V	**Linear Algebra** **Introduction of linear algebra related to Civil Engineering.** Elementary row operation 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. Rayleigh's power method. **Self-Study:** Solution of system of equations by Gauss-Jacobi iterative method, eigenvalues and eigenvectors-properties. **Applications:** Finding all the eigenvalues of a square matrix up to order 3by power method. **(RBT Levels: L1, L2 and L3).**	04	04

COURSE OUTCOMES: On completion of the course, students are able to:

CO1	**Describe** the translation of coordinate system, various types of series of functions, identify the variation of multi variables and match the system of equations in matrix form.
CO2	**Explain** the graph of function relate to polar coordinates, interpret series of continuous function and demonstrate the methods to describe mathematical solution to equations related to Engineering problems.
CO3	**Apply** the Mathematical properties to solve illustrative Engineering problems, calculate Maxima and minima of a function and calculate Eigenvalue relate to Eigenvector of system of equations.
CO4	**Make use of** matrix theory for solving for system of linear equations and compute eigenvalues and eigenvector
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/ MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44^{th} Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10^{th} Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011

CO5	**Familiarize** with modern mathematical tools namely MAXIMA/ MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011

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. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.

Web links and Video Lectures (e-Resources):

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

List of Laboratory experiments (2 hours/week per batch/batch strength 15): 10 lab sessions+ 1 repetition class+ 1 Lab Assessment.	
1	Analyzing standard 2D curves in polar, parametric and Cartesian forms. Also determining the point of intersection, nature of tangent and angle between polar curves.
2	Evaluation of bending of curves and nature at a given point on it.
3	Determination of flow of a multivariable function along the given direction and also identify the independence of given multivariable functions.
4	Determination of the optimal values of unconstrained function of at most two variables.
5	Determination of the primitive of first order differential equations
6	Solution of higher order ordinary differential equations.
7	Identifying the nature of given set of lines or planes using rank method.
8	Finding all the eigenvalues of a square matrix of order up to four using Rayleigh power method.
9	Solution of second order ordinary differential equations the method of variation of parameter.
10	Solution of simultaneous differential equations arises in circuit theory.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										

CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

I Semester:

Course Title	**Mathematics-1 (Differential Calculus, Differential Equations and Linear Algebra)**							
Course Code	**22MAU101B**							
Category	**ASC (Applied Science Course)**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	02	00	04	40	20	04
CIE Marks: 50	**SEE Marks: 50**		**Total Max. marks = 100**		**Duration of SEE: 03 Hours**			

COURSE LEARNING OBJECTIVES

1. **Familiarize** the importance of calculus associated with one variable and multivariable for computer science and engineering.
2. **Analyze** the solutions of the input-output relations involving system behaviours with the knowledge of ordinary differential equations.
3. **Apply** the knowledge of modular arithmetic to secure communications, to develop public and private key in cryptography.
4. **Develop** the knowledge of linear algebra to test the independence of data in data science involving vector spaces.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Differential Calculus** **Introduction to polar coordinates and curvature relating to Computer Science and 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 (without proof). **Self-study:** Centre and circle of curvature, evolutes and involutes. **Applications:** Tracing of polar curves. **(RBT Levels: L1, L2 and L3)**	04	04
II	**Series Expansion and Multivariable Calculus** **Introduction of series expansion and partial differentiation in Computer Science & Engineering.** Taylor's and McLaurin's series expansion of one variable (no proof). Partial differentiation, Euler's theorem, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables. **Self-study:** Extended Euler's theorem. Method of Lagrange's undetermined multipliers with single constraint. **Applications:** Solution of first order ODE arises using Taylor's series method.	04	04

	(RBT Levels: L1, L2 and L3)		
III	**Ordinary Differential Equations (ODEs)** **Introduction to ordinary differential equations pertaining to the applications for Computer Science & Engineering.** First order exact and reducible to exact differential equations. Higher order linear differential equations with constant coefficient-homogeneous and nonhomogeneous, inverse differential operator. **Self-Study:** First order linear and Bernoulli's differential equations. **Applications of ordinary differential equations:** Orthogonal trajectories. **(RBT Levels: L1, L2 and L3)**	04	04
IV	**Linear Algebra** **Introduction of linear algebra related to Computer Science & Engineering.** Elementary row operation 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. Rayleigh's power method. **Self-Study:** Solution of system of equations by Gauss-Jacobi iterative method, eigenvalues and eigenvectors-properties. **Applications:** Finding all the eigenvalues of a square matrix up to order 3 using Rayleigh power method,. **(RBT Levels: L1, L2 and L3).**	04	04
V	**Modular Arithmetic** **Introduction of modular arithmetic and its applications in Computer Science and Engineering.** Introduction to congruence's. Linear Diophantine equations, Basic properties of congruence's. Linear congruence's. System of Linear congruence's - Remainder theorem (no proof). Fermat's little theorem. Wilson Theorem. Applications of congruence's-RSA algorithm. **Self-Study:** GCD, Division algorithm, Euler's Theorem. **Applications:** Cryptography-encoding and decoding, RSA applications in public key encryption. **(RBT Levels: L1, L2 and L3)**	04	04

COURSE OUTCOMES: On completion of the course, students are able to:

CO1	**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.
CO2	**Analyze** the solution of linear and nonlinear ordinary differential equations.
CO3	**Get acquainted** and to apply modular arithmetic to computer algorithms
CO4	**Make use of** matrix theory for solving for system of linear equations and compute eigenvalues and eigenvector
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/ MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44^{th} Edition 2018), Khanna Publishers, New Delhi.
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3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011
4. David M Burton, Elementary Number Theory, McGraw Hill, 7th Ed., 2010.

CO4	**Make use of** matrix theory for solving for system of linear equations and compute eigenvalues and eigenvector
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/ MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

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3. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.
5. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4th Ed., 2018.
6. Gareth Williams, Linear Algebra with applications, Jones Bartlett Publishers Inc., 6th Ed., 2017.
7. William Stallings, Cryptography and Network Security, Pearson Prentice Hall, 6th Ed.,2013.

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2	Evaluation of bending of curves and nature at a given point on it.
3	Determination of flow of a multivariable function along the given direction and also identify the independence of given multivariable functions.
4	Determination of the optimal values of unconstrained function of at most two variables.
5	Determine the primitive of first order differential equations
6	Solution of higher order ordinary differential equations.
7	Identifying the nature of given set of lines or planes using rank method.
8	Finding all the eigenvalues of a square matrix of order up to four using Rayleigh power method.
9	Solution of linear congruence's, Diophantine equations, second order ordinary differential equations by variation of parameter.

10	System of Linear congruence's using chariness remainder theorem.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

I Semester:

Course Title	Mathematics-1 (Differential Calculus, Differential Equations and Linear Algebra)							
Course Code	22MAU101C							
Category	ASC (Applied Science Course)							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	02	00	04	40	20	04
CIE Marks: 50	SEE Marks: 50	Total Max. marks = 100		Duration of SEE: 03 Hours				

COURSE LEARNING OBJECTIVES

1. **Familiarize** the importance of calculus associated with one variable and two variables.
2. **Analyze** Engineering problems by applying Ordinary Differential Equations.
3. **Develop** the knowledge of Linear Algebra to solve system of equation by using matrices.
4. **Apply** the knowledge of Calculus, Ordinary Differential Equations and Linear Algebra in the field of mechanical engineering.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Differential Calculus** **Introduction to polar coordinates and curvature relating to Mechanical 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 (without proof). **Self-study:** Centre and circle of curvature, evolutes and involutes. **Applications:** Tracing of polar curves. **(RBT Levels: L1, L2 and L3)**	04	04
II	**Series Expansion and Multivariable Calculus** **Introduction of series expansion and partial differentiation in Mechanical Engineering.** Taylor's and McLaurin's series expansion of one variable (no proof). Partial differentiation, Euler's theorem, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables. **Self-study:** Extended Euler's theorem. Method of Lagrange's undetermined multipliers with single constraint. **Applications:** Solution of first order ODE using Taylor's series method. **(RBT Levels: L1, L2 and L3)**	04	04
III	**Differential Equations-I** **Introduction to ordinary differential equations pertaining to the**	04	04

	applications for Mechanical Engineering. First order exact and reducible to exact differential equations. Higher order linear differential equations with constant coefficient-homogeneous and nonhomogeneous, inverse differential operator. **Self-Study:** First order linear and Bernoulli's differential equations. **Applications of ordinary differential equations:** Orthogonal trajectories. **(RBT Levels: L1, L2 and L3)**		
IV	**Differential Equations-II** **Importance of Ordinary differential equations (ODE's) of higher order in Mechanical Engineering.** Method of variation of parameter, Cauchy's and Legendre's differential equations, simultaneous linear differential equations. **Self study:** Method of Undetermined coefficient. **Application:** Oscillation of a spring. **(RBT Levels : L1,L2 and L3)**		
V	**Linear Algebra** **Introduction of linear algebra related to Mechanical Engineering.** Elementary row operation 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. Rayleigh's power method. **Self-Study:** Solution of system of equations by Gauss-Jacobi iterative method, eigenvalues and eigenvectors-properties. **Applications:** Finding all the eigenvalues of a square matrix up to order 3 using Rayleigh method. **(RBT Levels: L1, L2 and L3).**	04	04

COURSE OUTCOMES: On completion of the course, students are able to:

CO1	**Describe** the translation of coordinate system, various types of series of functions, identify the variation of multivariable functions and match the system of equations in matrix form.
CO2	**Explain** the graph of function relate to polar coordinates, interpret series of continuous function and demonstrate the methods to describe mathematical solution to equations related to Engineering problems.
CO3	**Apply** the Mathematical properties to solve illustrative Engineering problems, calculate Maxima and minima of a function and calculate Eigenvalue relates to Eigenvector of system of equations.
CO4	**Analyze** the Mathematical model of differential and systems of equations of more than one variable classify various solutions to problems, enumerate numerical solutions to system of equations.
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/MATLAB/ PYTHON/ SCILA.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011

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	numerical solutions to system of equations.
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/MATLAB/ PYTHON/ SCILA.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

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2	Evaluation of bending of curves and nature at a given point on it.
3	Determination of flow of a multivariable function along the given direction and also identify the independence of given multivariable functions.
4	Determination of the optimal values of unconstrained function of at most two variables.
5	Determine the primitive of first order differential equations
6	Solution of higher order ordinary differential equations.
7	Identifying the nature of given set of lines or planes using rank method.
8	Finding all the eigenvalues of a square matrix of order up to four using Rayleigh power method.
9	Solution of second order ordinary differential equations by variation of parameter.
10	Solution of simultaneous differential equations arises in circuit theory.

CO-PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1										
CO2	3	2										

CO3	2	3									
CO4	3	2									
CO5	2	3									
Strength of correlation: Low-1, Medium-2, High-3											

I Semester

Course Title	Mathematics-1 (Differential Calculus, Differential Equations and Linear Algebra)							
Course Code	22MAU101D							
Category	ASC (Applied Science Course)							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	02	00	04	40	20	04
CIE Marks: 50	SEE Marks: 50		Total Max. marks = 100		Duration of SEE: 03 Hours			

COURSE LEARNING OBJECTIVES

1. **Familiarize** the importance of calculus associated with one variable and multivariable for Electrical & Electronics Engineering.
2. **Analyze** Engineering problems by applying Ordinary Differential Equations.
3. **Apply** the knowledge of integral calculus.
4. **Develop** the knowledge of linear algebra to solve the system of equations.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Differential Calculus** **Introduction to polar coordinates and curvature relating to Electrical & Electronics 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 (without proof). **Self-study:** derivative of arc length, envelope. **Applications:** Tracing of polar curves. **(RBT Levels: L1, L2 and L3)**	04	04
II	**Series Expansion and Multivariable Calculus** **Introduction of series expansion and partial differentiation in Electrical & Electronics Engineering.** Introduction to quadratic approximation, Taylor's and Maclaurin's series expansion of one variable (no proof). Partial differentiation, Euler's theorem, total derivative - differentiation of composite functions. Jacobian. Maxima and minima for a function of two variables. **Self-study:** Extended Euler's theorem. Method of Lagrange's undetermined multipliers with single constraint. **Applications:** Solution of ODE arises using Taylor's series method. **(RBT Levels: L1, L2 and L3)**	04	04
III	**Ordinary Differential Equations (ODEs)** **Introduction to ordinary differential equations pertaining to the applications for Electrical & Electronics Engineering.** Exact and reducible to exact differential equations. Orthogonal trajectories. Higher order linear differential equations with constant coefficient-	04	04

	homogeneous and nonhomogeneous, inverse differential operator. **Self-Study:** Linear and Bernoulli's differential equations. **Applications:** L-R-C circuits. **(RBT Levels: L1, L2 and L3)**		
IV	**Linear Algebra** **Introduction of linear algebra related to Electrical & Electronics Engineering.** Elementary row operation 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. Dominant Eigenvalue by Rayleigh's power method. **Self-Study:** Solution of system of equations by Gauss-Jacobi iterative method, Eigenvalues and Eigenvectors-properties. **Applications:** Optimum solution by least square method for inconsistent system. **(RBT Levels: L1, L2 and L3).**	04	04
V	**Integral Calculus** **Introduction to Integral Calculus in Electrical & Electronics Engineering.** **Multiple Integrals:** Evaluation of double and triple integrals, evaluation of double integrals over the region, change of order of integration and changing into polar coordinates.. **Beta and Gamma functions:** Definitions, properties, relation between Beta and Gamma functions, duplication formula. **Self-Study:** Center of gravity, Volume by double integrals. **Applications:** Area by double integral and volume by triple integral **(RBT Levels: L1, L2 and L3)**	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**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.
CO2	**Analyze** the solution of linear and nonlinear ordinary differential equations.
CO3	**Apply** the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing area and volume
CO4	**Make** use of matrix theory for solving for system of linear equations and compute eigenvalues and eigenvectors
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

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4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.

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5. VTU EDUSAT Program
6. https://www.wolfram.com/customer-stories/designing-hearing-aid-parts-with-mathematica.html
7. https://www.youtubeeducation.com/watch?v=3d6DsjIBzJ4

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2	Evaluation of bending of curves and nature at a given point on it.
3	Determination of flow of a multivariable function along the given direction and also identify the independence of given multivariable functions.
4	Determination of the optimal values of unconstrained function of at most two variables.
5	Determine the primitive of first order differential equations
6	Solution of higher order ordinary differential equations.
7	Identifying the nature of given set of lines or planes using rank method.
8	Finding all the eigenvalues of a square matrix of order up to four using Rayleigh power method.
9	Evaluation of triple integrations, finding average values and centroid.
10	Evaluation of gamma and beta functions.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										

Strength of correlation: Low-1, Medium-2, High-3

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

II Semester:

<table>
<tr><td>Course Title</td><td colspan="8">Mathematics-II
(Integral Calculus, Partial Differential Equations and Numerical methods)</td></tr>
<tr><td>Course Code</td><td colspan="8">22MAU201A</td></tr>
<tr><td>Category</td><td colspan="8">ASC (Applied Science Course)</td></tr>
<tr><td rowspan="3">Scheme and Credits</td><td colspan="5">Theory/Practical/Integrated</td><td rowspan="2">Total teaching hours</td><td rowspan="2">Lab slots</td><td rowspan="2">Credits</td></tr>
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<tr><td>02</td><td>02</td><td>02</td><td>00</td><td>04</td><td>40</td><td>20</td><td>04</td></tr>
<tr><td>CIE Marks: 50</td><td colspan="2">SEE Marks: 50</td><td colspan="2">Total Max. marks = 100</td><td colspan="4">Duration of SEE: 03 Hours</td></tr>
</table>

COURSE LEARNING OBJECTIVES

1. **Familiarize** the fundamentals of Integral calculus, Vector calculus, Numerical Techniques
2. **Analyze** Engineering problems by applying Partial Differential Equations Methods
3. **Develop** the knowledge of solving engineering problems by using numerical Technique
4. **Apply** the knowledge of calculus, partial differential equations and numerical techniques in various fields of civil engineering.

<table>
<tr><td rowspan="2">Unit</td><td rowspan="2">Syllabus content</td><td colspan="2">No. of hours</td></tr>
<tr><td>Theory</td><td>Tutorial</td></tr>
<tr><td>I</td><td>Introduction to Integral Calculus in Civil Engineering.
Multiple Integrals: Evaluation of double and triple integrals, change of order of integration, changing into polar coordinates.
Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions.
Self-Study: Center of gravity, volume by double integration, duplication formula.
Applications: Area by double integration and Volume by triple integration.
(RBT Levels: L1, L2 and L3)</td><td>04</td><td>04</td></tr>
<tr><td>II</td><td>Vector Calculus
Introduction to Vector Calculus in Civil Engineering.
Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields. Vector identities (without proof).
Vector Integration: Line integrals, Surface integrals, Green's theorem and Stoke's theorem (no proofs).
Self-Study: Differentiation of vector function of time, volume integral and Gauss divergence theorem.
Applications: velocity and acceleration.
(RBT Levels: L1, L2 and L3)</td><td>04</td><td>04</td></tr>
<tr><td>III</td><td>Partial Differential Equations (PDE):
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.</td><td>04</td><td>04</td></tr>
</table>

	Method of separation of variables. **Self-Study**: One-dimensional heat equation and wave equation. **Applications: S**olution of one-dimensional heat equation and wave equation by the method of separation of variables. (**RBT Levels:** L1, L2 and L3)		
IV	**Numerical methods-1** **Importance of Numerical methods for discrete data in the field of Civil Engineering.** Solution of algebraic and transcendental equations, Regula-Falsi, Newton-Raphson methods and Ramanujan's methods (no proofs). Finite differences. Interpolation-Newton's Gregory forward and backward,Gauss forward and backward, Stirling's (no proofs). Newton's divided difference formula (no proof). **Self-Study:** Bisection method, Secant method, Lagrange's interpolation, inverse Interpolation. **Applications:** Estimating the approximate roots by inverse interpolation. (**RBT Levels:** L1, L2 and L3)	04	04
V	**Numerical methods -2** **Introduction to various numerical techniques for handling Civil Engineering application:** **Numerical integration:** Trapezoidal, Simpson's 1/3 rule and 3/8 rules, Weddle's rule (without proof). **Numerical Solution of Ordinary Differential Equations (ODE's):** Solutions of first order and first degree – Picard's method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations). **Self-Study**: Taylor's series method, Euler's method, Adam-Bashforth method. **Applications:** Solutions to ODE arises in civil engineering. (**RBT Levels:** L1, L2 and L3)	04	04

COURSE OUTCOMES: On completion of the course, students are able to

CO1	**Describe multiple integrals,** scalar and vector point functions of two, solution of partial differential equations and Numerical approximations.
CO2	**Explain** concepts of area and volume by double integration, change to polar coordinates describe divergence and flux in vector field; classify method of solutions of PDE's, Numerical differentiation and integrations.
CO3	**Apply** the Mathematical properties to evaluate triple integral and improper integral to interpret the irrotational and solenoidal vector field, find the solutions to problem arises in engineering field.
CO4	**Analyze** multiple integrals, vector differentiations and integration, the Mathematical model by partial differential equations, Numerical solution to algebraic and transcendental, ordinary differential equations.
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/ MATLAB/ PYTHON/ SCILAB

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011.

4. Wei-Chau Xie, Differential Equations for Engineers, Cambridge University Press, 1st ED.,2010.

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. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., NewYork, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed.,2014.

Web links and Video Lectures (e-Resources):

1. http://www.nptel.ac.in
2. https://en.wikipedia.org
3. http://academicearth.org/
4. VTU e-Shikshana Program
5. VTU EDUSAT Program
6. http://mcatutorials.com/mca-tutorials-numerical-methods-tutorial.php

List of Laboratory experiments (2 hours/week per batch/batch strength 15): 10 lab sessions+ 1 repetition class+ 1 Lab Assessment.	
1	Evaluation of multiple integrals and application to determine area, volume and surface area of standard objects.
2	Evaluation of Gamma and Beta functions.
3	Vector differential operator applied on scalar and vector point functions and its application problems.
4	Verification of Green's theorem.
5	Solution of one-dimensional heat equation and wave equation
6	Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson Method
7	Interpolation/Extrapolation using Newton's forward and backward difference formula
8	Application of quadrature formula.
9	Solution of linear first order ordinary differential equations by Modified Euler's Method and Picard's method.
10	Solution of linear first order ordinary differential equations by Runge-Kutta IVth order and Predictor-corrector methods.

CO-PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

II Semester:

<table>
<tr><td>Course Title</td><td colspan="8">Mathematics-II
(Integral Calculus, Vectors calculus, Numerical methods and Vector spaces)</td></tr>
<tr><td>Course Code</td><td colspan="8">22MAU201B</td></tr>
<tr><td>Category</td><td colspan="8">ASC (Applied Science Course)</td></tr>
<tr><td rowspan="3">Scheme and Credits</td><td colspan="5">Theory/Practical/Integrated</td><td rowspan="2">Total teaching hours</td><td rowspan="2">Lab slots</td><td rowspan="2">Credits</td></tr>
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<tr><td>CIE Marks: 50</td><td colspan="2">SEE Marks: 50</td><td colspan="2">Total Max. marks = 100</td><td colspan="4">Duration of SEE: 03 Hours</td></tr>
</table>

COURSE LEARNING OBJECTIVES

1. **Familiarize** the fundamentals of Integral calculus and Vector calculus
2. **Learn** vector spaces and linear transformations
3. **Develop** the knowledge of solving numerical methods and apply them to solve transcendental and differential equations.
4. **Apply** the knowledge of calculus, vector space, linear transformation and numerical techniques in various fields of computer science and engineering

<table>
<tr><th rowspan="2">Unit</th><th rowspan="2">Syllabus content</th><th colspan="2">No. of hours</th></tr>
<tr><th>Theory</th><th>Tutorial</th></tr>
<tr><td>I</td><td>Integral Calculus
Introduction to Integral Calculus in Computer Science & Engineering.
Multiple Integrals: Evaluation of double and triple integrals, evaluation of double integrals over the region, evaluation of double integrals by changeof order of integration and changing into polar coordinates.
Beta and Gamma functions: Definitions, properties, relation between Beta and Gamma functions.
Self-Study: Center of gravity, Volume by double integrals.
Applications: Applications to find area by double integral and volume by triple integral.
(RBT Levels: L1, L2 and L3)</td><td>04</td><td>04</td></tr>
<tr><td>II</td><td>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, vector identities (no proof).
Curvilinear coordinates: Scale factors, base vectors, Cylindrical polar coordinates, Spherical polar coordinates, transformation between Cartesian and curvilinear systems, orthogonally.
Self-Study: Expressions of curl, divergence and gradient in orthogonal curvilinear coordinates.
Applications: velocity and acceleration.
(RBT Levels: L1, L2 and L3)</td><td>04</td><td>04</td></tr>
</table>

III	**Vector Space and Linear Transformations** **Importance of Vector Space and Linear Transformations in the field of Computer Science & Engineering.** **Vector spaces:** Definition and examples, subspace, linear span, Linearly independent and dependent sets, Basis and dimension (No theorems) **Linear transformations:** Definition and examples, Matrix of a linear transformation. Rank and nullity of a linear operator, rank-nullity theorem (Only statement). **Self-study:** Angles and Projections. Rotation, reflection, contraction and expansion. **Applications:** Image processing. (RBT Levels: L1, L2 and L3)	04	04
IV	**Numerical methods -1** **Importance of numerical methods for discrete data in the field of computer science & engineering.** Solution of algebraic and transcendental equations – Ramanujan's method, Regula-Falsi and Newton-Raphson methods (no proofs). Finite differences, Interpolation formula- Newton's Gregory forward and backward, Gauss forward and backward, Stirling's (no proofs). Newton's divided difference formula (no proof). **Self-Study:** Bisection method, Secant method, Lagrange's interpolation, inverse Interpolation. **Applications:** Estimating the approximate roots by inverse interpolation. (RBT Levels: L1, L2 and L3)	04	04
V	**Numerical methods -2** **Introduction to various numerical techniques for handling Computer Science & Engineering applications.** **Numerical integration:** Trapezoidal, Simpson's (1/3)rd and (3/8)th rules, and Weddle's rule(without proof). **Numerical Solution of ODE:** Solutions of first order and first degree ODE-Picard's method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations). **Self-Study:** Taylor's series method, Euler's method, Adam-Bashforth method. **Applications:** estimating the approximate solutions of ODE. (RBT Levels: L1, L2 and L3)	04	04

COURSE OUTCOMES: On completion of the course, students are able to:

CO1	Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing area and volume.
CO2	Understand the applications of vector calculus refer to solenoidal and irrotational vectors. Orthogonal curvilinear coordinates**.**
CO3	Demonstrate the idea of Linear dependence and independence of sets in the vector space and linear transformation**.**
CO4	Apply the knowledge of numerical methods in analyzing the discrete data and solving the physical and engineering problems**.**
CO5	Get familiarize with modern mathematical tools namely MATHEMATICA/ MATLAB /PYTHON/ SCILAB.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.

2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011
4. David M Burton, Elementary Number Theory, McGraw Hill, 7th Ed., 2010.
5. Kenneth Hoffman and Ray Kunze, Linear Algebra, Person 2 ED., 2016.

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. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.
5. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4th Ed., 2018.
6. Gareth Williams, Linear Algebra with applications, Jones Bartlett Publishers Inc., 6th Ed., 2017.
7. William Stallings, Cryptography and Network Security, Pearson Prentice Hall, 6th Ed.,2013.

Web links and Video Lectures (e-Resources):

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU e-Shikshana Program
5. VTU EDUSAT Program
6. https://www.youtube.com/watch?v=TjIrEYWlonE
7. http://mcatutorials.com/mca-tutorials-numerical-methods-tutorial.php
8. http://nitttrc.edu.in/nptel/courses/video/108106171/108106171.html

List of Laboratory experiments (2 hours/week per batch/batch strength 15): **10 lab sessions+ 1 repetition class+ 1 Lab Assessment.**	
1	Evaluation of multiple integrals and application to determine area, volume and surface area of standard objects.
2	Evaluation of Gamma and Beta functions.
3	Vector differential operator applied on scalar and vector point functions and its application problems.
4	Verification of Green's theorem.
5	Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson Method.
6	Interpolation using Newton's forward, backward difference formula and central difference formula.
7	Application of quadrature formula.
8	Solution of linear first order ordinary differential equations by Modified Euler's Method and Picard's method.
9	Solution of linear first order ordinary differential equations by Runge-Kutta IVth order and Predictor-corrector methods.
10	Testing independence of vectors, computation of basis and dimension a vector space.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

II Semester:

Course Title	**Mathematics-II** **(Integral Calculus, Partial Differential Equations and Numerical methods)**							
Course Code	**22MAU201C**							
Category	**ASC (Applied Science Course)**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	02	00	04	40	20	04
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**				

COURSE LEARNING OBJECTIVES

1. **Familiarize** the fundamentals of Integral calculus, Vector calculus, Numerical Techniques
2. **Analyze** engineering problems by applying Partial Differential Equations Methods
3. **Develop** the knowledge of solving engineering problems by using numerical Technique
4. **Apply** the knowledge of calculus, partial differential equations and numerical techniques in various fields of mechanical engineering.

Unit	Syllabus content	No. of hours	
		Theory	**Tutorial**
I	**Introduction to Integral Calculus in Mechanical Engineering.** Multiple Integrals: Evaluation of double and triple integrals, change of order of integration, changing into polar coordinates. **Beta and Gamma functions**: Definitions, properties, relation between Beta and Gamma functions. **Self-Study**: Center of gravity, volume by double integration, duplication formula. **Applications:** Area by double integration and Volume by triple integration. (**RBT Levels:** L1, L2 and L3)	04	04
II	**Vector Calculus** **Introduction to Vector Calculus in Mechanical Engineering.** **Vector Differentiation**: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields. Vector identities (without proof). **Vector Integration**: Line integrals, Surface integrals, Green's theorem and Stoke's theorem (no proofs). **Self-Study**: Differentiation of vector function of time, volume integral and Gauss divergence theorem. **Applications:** velocity and acceleration. (**RBT Levels:** L1, L2 and L3)	04	04
III	**Partial Differential Equations (PDE)**: Formation of PDE's by elimination of arbitrary constants and functions. Solution of non- homogeneous PDE by direct integration. Homogeneous	04	04

	PDEs involving derivative with respect to one independent variable only. Introduction to method of separation of variables. **Self-Study**: One-dimensional heat equation and wave equation. **Applications: S**olution of one-dimensional heat equation, wave equation and two dimensional Laplace equation by the method of separation of variables. (**RBT Levels:** L1, L2 and L3)		
IV	**Numerical methods-1** **Importance of Numerical methods for discrete data in the field of Mechanical Engineering.** Solution of algebraic and transcendental equations, Regula-Falsi, Newton-Raphson methods and Ramanujan's methods (no proofs). Finite differences. Interpolation-Newton's Gregory forward and backward,Gauss forward and backward, Stirling's (no proofs). Newton's divided difference formula (no proof). **Self-Study:** Bisection method, Secant method, Lagrange's interpolation, inverse Interpolation. **Applications:** Estimating the approximate roots by inverse interpolation. (**RBT Levels:** L1, L2 and L3)	04	04
V	**Numerical methods -2** **Introduction to various numerical techniques for handling Mechanical Engineering application:** **Numerical integration:** Trapezoidal, Simpson's 1/3 rule and 3/8 rules, Weddle's rule (without proof). **Numerical Solution of Ordinary Differential Equations (ODE's):** Solutions of first order and first degree – Picard's method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations). **Self-Study**: Taylor's series method, Euler's method, Adam-Bashforth method. **Applications:** Solution of ODE by numerical methods in Mechanical engineering (**RBT Levels:** L1, L2 and L3)	04	04

COURSE OUTCOMES: On completion of the course, students are able to:

CO1	**Knowledge** to evaluate double and triple integration and identify the scalar, vector notation of functions of two and three dimensions, recognize the partial differential equations and Numerical differences
CO2	**Understand** to explain Area, Volume by double integration, change to polar coordinates describe divergence and flux in vector field; classify method of solutions of PDE's, Numerical differentiation and integrations.
CO3	**Apply** the Mathematical properties to evaluate triple integral and improper integral to interpret the irrotational and solenoidal vector field, find the solutions to problem arises in engineering field.
CO4	**Analyze** multiple integrals ,vector differentiations and integration, the Mathematical model by partial differential equations, Numerical solution to algebraic and transcendental, ordinary differential equations
CO5	**Familiarize** with modern mathematical tools namely MAXIMA/MATLAB/ PYTHON/ SCILA.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

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3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011

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3. C. Ray Wylie, Louis C. Barrett**,** Advanced Engineering Mathematics, McGraw Hill Book Co., NewYork, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed.,2014.

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1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU e-Shikshana Program
5. VTU EDUSAT Program
6. https://www.youtube.com/watch?v=TjIrEYWlonE
7. http://mcatutorials.com/mca-tutorials-numerical-methods-tutorial.php

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2	Evaluation of Gamma and Beta functions.
3	Vector differential operator applied on scalar and vector point functions and its application problems.
4	Verification of Green's theorem.
5	Solution of one-dimensional heat equation and wave equation.
6	Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson Method.
7	Interpolation using Newton's forward, backward difference formula and central difference formula.
8	Application of quadrature formula.
9	Solution of linear first order ordinary differential equations by Modified Euler's Method and Picard's method.
10	Solution of linear first order ordinary differential equations by Runge-Kutta IVth order and Predictor-corrector methods.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

II Semester

<table>
<tr><td>Course Title</td><td colspan="8">Mathematics-II
(Laplace transforms, Vectors, Numerical methods and Vector spaces)</td></tr>
<tr><td>Course Code</td><td colspan="8">22MAU201D</td></tr>
<tr><td>Category</td><td colspan="8">ASC (Applied Science Course)</td></tr>
<tr><td rowspan="3">Scheme and Credits</td><td colspan="5">Theory/Practical/Integrated</td><td rowspan="2">Total teaching hours</td><td rowspan="2">Lab slots</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>SDA</td><td>Total</td></tr>
<tr><td>02</td><td>02</td><td>02</td><td>00</td><td>04</td><td>40</td><td>20</td><td>04</td></tr>
<tr><td>CIE Marks: 50</td><td colspan="2">SEE Marks: 50</td><td colspan="2">Total Max. marks = 100</td><td colspan="4">Duration of SEE: 03 Hours</td></tr>
</table>

COURSE LEARNING OBJECTIVES

1. **Familiarize** the importance of Vector calculus essential for Electronics and Electrical Engineering.
2. **Learn** vector spaces and linear transformations
3. **Develop** the knowledge of solving numerical methods and apply them to solve transcendental and differential equations.
4. **Apply** the knowledge of calculus, Laplace transform, vector space, linear transformation and numerical techniques in various fields of Electrical & Electronics Engineering

<table>
<tr><th rowspan="2">Unit</th><th rowspan="2">Syllabus content</th><th colspan="2">No. of hours</th></tr>
<tr><th>Theory</th><th>Tutorial</th></tr>
<tr><td>I</td><td>Laplace Transform
Importance of Laplace Transform for Electrical & ElectronicsEngineering.
Definition of Laplace transform (LT), transform of elementary functions,region of convergence, Properties–linearity, scaling, t-shift property, s-domain shift, differentiation in the domain, division by t, differentiation and integration in the time domain, LT of special functions-periodic functions, Heaviside unit step function. (All properties and theorems no proof).
Inverse Laplace Transforms:
Definition, evaluation using partial fraction methods, convolution theorem (without proof).
Self-Study: Verification of convolution theorem.
Applications: Applications to solve ordinary differential equations. (RBT Levels: L1, L2 and L3)</td><td>04</td><td>04</td></tr>
<tr><td>II</td><td>Vector Calculus
Introduction to Vector Calculus in Electrical & Electronics Engineering.
Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields.
Vector Integration: Line integrals, Applications to work done by a force and flux. Statement of Green's theorem Surface integrals and Stoke's theorem.
Self-Study: Volume integral and Gauss divergence theorem.
Applications: velocity and acceleration.</td><td>04</td><td>04</td></tr>
</table>

	(RBT Levels: L1, L2 and L3)		
III	**Vector Space and Linear Transformations** **Importance of Vector Space and Linear Transformations in the field of Electrical & Electronics Engineering.** **Vector spaces:** Definition and examples, subspace, linear span, Linearly independent and dependent sets, Basis and dimension (No theorems). **Linear transformations**: Definition and examples, Matrix of a linear transformation. Rank and nullity of a linear operator, Rank-Nullity theorem (no proof). **Self-study:** Angles and Projections. Rotation, reflection, contraction and expansion. **Applications:** Image processing. **(RBT Levels: L1, L2 and L3)**	04	04
IV	**Numerical methods -1** **Importance of numerical methods for discrete data in the field of Electrical & Electronics Engineering.** Solution of algebraic and transcendental equations – Ramanujan's method, Regula-Falsi and Newton-Raphson methods (no proofs). Finite differences, Interpolation formula- Newton's Gregory forward and backward, Gauss forward and backward, Stirling's (no proofs). Newton's divided difference formula (no proof). **Self-Study:** Bisection method, Secant method, Lagrange's interpolation and Lagrange's inverse Interpolation. **Applications:** Estimating the approximate roots by inverse interpolation. (RBT Levels: L1, L2 and L3)	04	04
V	**Numerical methods -2** **Introduction to various numerical techniques for handling Electrical & Electronics Engineering.** **Numerical integration:** Trapezoidal, Simpson's (1/3)rd and (3/8)th rules, and Weddle's rule(without proof). **Numerical Solution of Ordinary Differential Equations (ODE's):** Solutions of first order and first degree – Picard's method, Modified Euler's method, Runge-Kutta method of fourth order and Milne's predictor-corrector formula (No derivations). **Self-Study:** Runge-Kutta method of second order, Adam-Bashforth method. **Applications:** Estimating the approximate solutions of ODE . (RBT Levels: L1, L2 and L3)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Apply** the concept of changing time filed to s-field using Laplace transformation as a tool to solve the definite integrals, differential equations, and problems arises in signals and systems.
CO2	**Understand** the applications of vector calculus refer to solenoidal and irrotational vectors, line integrals and surface integrals often in most of the electrical and electronics fields**.**
CO3	**Demonstrate** the idea of Linear dependence and independence of sets in the vector space and linear transformation**.**
CO4	**Apply** the knowledge of numerical methods in analyzing the discrete data and solving the physical and engineering problems**.**
CO5	**Get familiarize** with modern mathematical tools namely MATHEMATICA/

	MATLAB /PYTHON/ SCILAB.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4th ED., 2011
4. Peter v. O'neil, advanced Engineering Mathematics, Cengage learning, 7th ed., 2012.
5. Kenneth Hoffman and Ray Kunze, Linear Algebra, Person 2 ED., 2016.

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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. David C Lay, Linear Algebra and its Applications, Pearson Publishers, 4th Ed., 2018.
4. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
5. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.

Web links and Video Lectures (e-Resources)

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU e-Shikshana Program
5. VTU EDUSAT Program
6. https://www.youtube.com/watch?v=TjIrEYWlonE
7. http://mcatutorials.com/mca-tutorials-numerical-methods-tutorial.php
8. http://nitttrc.edu.in/nptel/courses/video/108106171/108106171.html

List of Laboratory experiments (2hours/week per batch/batch strength 15) **10 lab sessions +1 repetition class + 1 Lab Assessment**	
1	Computing Laplace Transform and inverse Laplace Transform of standard function.
2	Laplace Transform of convolution of two functions.
3	Vector differential operator applied on scalar and vector point functions and its application problems.
4	Verification of Green's theorem.
5	Solution of algebraic and transcendental equations by Regula-Falsi and Newton-Raphson Method.
6	Interpolation using Newton's forward, backward difference formula and central difference formula.
7	Application of quadrature formula.
8	Solution of linear first order ordinary differential equations by Modified Euler's Method and Picard's method.
9	Solution of linear first order ordinary differential equations by Runge-Kutta IVth order and Predictor-corrector methods.
10	Testing independence of vectors, computation of basis and dimension a vector space.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

III Semester

Course Title	**Mathematics-III (Probability and Statistical Inference).**							
Course Code	**22MAT301B**							
Category	**ASC (Applied Science Course)**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	03	02	00	00	04	50	00	04
CIE Marks: 50	**SEE Marks: 50**		**Total Max. marks = 100**		**Duration of SEE: 03 Hours**			

COURSE LEARNING OBJECTIVES

This course is proposed to impart to the students the skills to identify and solve real life problems in their field of study involving the application of the concepts of probability, statistical inferences and ANOVA testing.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Probability Distributions:** Recap of Random Variables. Probability generating function, moment generating function, expectations. Discrete probability distributions-Binomial, Poisson and Geometric distributions; Continuous probability distributions-Exponential, Normal and Weibull distributions. **Self-study***:* Gamma distributions. **Applications:** Transmission errors in noise media. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**Two dimensional Random variables:** Joint probability mass function, Marginal probability function,conditional probability function. **Random Process:** Classification of random process, description of random process, stationary random process – first order, second order and Strict-sense stationary processes, Autocorrelation and Cross- correlation functions. **Self-study**: Joint density function, marginal density function, conditional probability density function, covariance, correlation coefficient. **Application**: Bayesian network. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Statistical Inference:** Introduction sampling distribution standard errors, level of significance, confidence limits for sampling of attributes, test of significance for large samples. Comparison of large samples, central limit theorem, confidence limit for unknown mean, testing of mean of large two samples, students *t*-distribution , chi-square distribution. **Self-study:** *F*-distribution. **Application:** Goodness of fitness (RBT levels: **L1, L2, L3, L4**)	04	04
IV	**Markov Chain:** Introduction to Stochastic Process, Probability Vectors, Stochastic matrices, Markov chains, Higher transition probabilities, Stationary distribution of Regular Markov chains and absorbing states. **Self-study:** Regular stochastic matrices **Applications:** model the behaviour of stock prices, spread of a disease through a population, birth-death process.	04	04

	(RBT levels: **L1, L2, L3, L4**)		
V	**Design of Experiments & ANOVA :** Principles of experimentation in design, Analysis of completely randomized design, randomized block design. The ANOVA Technique, basic principle of ANOVA, One way ANOVA, Two-way ANOVA. **Self-study**: latin-square design. **Applications**: to determine the best materials to use to build a product for a customer, to test effectiveness of different marketing strategies. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Learn** a mathematical tool to estimate the life time for a system and also time of failure.
CO2	**Predict** most suitable distributions, happening of favorable event.
CO3	**Analyze** the statistical inferences and the basics of Hypothesis testing with emphasis on some commonly encountered hypothesis.
CO4	**Employ** the knowledge of probability, joint probability distributions, Markov chain in pattern recognition.
CO5	**Apply** ANOVA testing to determine significant effect of input on the system's response.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

Assignment: Python programmers on in Units-I to V to be given as assignment using the Textbook indicated in item 5 below.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Ed., 2018.
2. Kishore S. Trivedi, Probabilty and Statistics with Reliability, Queuing and Computer Science Applications, Wiely India publication, 2nd ED., 2008
3. Sundaran Pillai, Probabililty, Statistics and Queuing theory, PHI, 2009.
4. G. Haribaskaran, Prbabiltly Queuing Theory and Reliability Engineering, 2nd Ed., 2006.
5. Peter Bruce, Andrew Bruce and Peter Gedeck, Practical Statistics for Data Scientists, O'REILLY, 2Ed., 2020.

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. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.

Web links and Video Lectures (e-Resources)

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										

CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

III Semester

Course Title	**Mathematics-III (Fourier transforms, Z-transforms and Probability distributions)**							
Course Code	**22MAT301D**							
Category	**ASC (Applied Science Course)**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	03	02	00	00	04	50	00	04
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**				

COURSE LEARNING OBJECTIVES

1 **Learn** the mathematical transformations that sends a signal sampled in time or space to the same signal sampled in temporal or spatial frequency.

2 **Understand** a methodology that converts a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency-domain or into a standard distribution.

3 **Develop** the knowledge of solving differential equations, difference equations, transmission errors arises in electrical and electronics engineering, and validating the distribution.

4. **Analyze** signals in terms of Fourier series, Fourier transforms and standard distributions.

4 **Apply** the knowledge of Fourier series, Z-transform, Probability distributions, and hypothesis testing to complex engineering problems in Electrical & Electronics Engineering.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Fourier series:** Periodic function, Dirichlet's condition, conditions for a Fourier series expansion, Fourier series of functions with period 2π and with arbitrary period. Half range Fourier series. **Self-study:** Typical waveforms, complex form of Fourier series. **Application:** Practical harmonic analysis, variation of periodic current, solution of boundary value problems. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**Fourier Transforms:** Definition, infinite Fourier transforms, inverse Fourier transforms, Fourier sine and cosine transforms, inverse Fourier sine and cosine transforms, Convolution theorem of Fourier transforms. **Self-study:** Parseval's identity (no proof). **Application:** Fourier transform of derivatives, solution of boundary value problems. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Z-Transforms:** Definition, Z-transforms of basic sequences and standard functions. Properties- linearity, scaling, first and second shifting, multiplication by *n*, initial and final value theorem- problems. Inverse Z-transforms-problems. **Self-study:** Linear difference equations with constant coefficients. **Application:** Application to solve first order difference equation using Z-transforms. (RBT levels: **L1, L2, L3, L4**)	04	04

IV	**Probability Distributions:** Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation, mean and variance. Binomial, Poisson , normal and exponential distributions (no proof). **Self-study:** Geometric and Gamma distributions. **Application:** Application to transmission errors in noise media, (RBT levels: **L1, L2, L3, L4**)	04	04
V	**Statistical Inference:** Introduction to sampling distributions, standard error, level of significance, confidence limits for sampling of attributes, test of significance for large samples, comparison of large samples, central limit theorem, confidence limit for unknown mean, testing of means of two large samples, students t-distribution, chi square distribution . **Self-study:** F-distribution **Application:** goodness of fitness. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Develop** Fourier series to study the behavior of periodic functions and their applications in system communications, digital signal processing and field theory.
CO2	**Apply** Fourier and Z-transforms for solving problems connected to continuous and discrete-time signal processing
CO3	**Analyze** electrical circuits and stability of communication systems using Fourier and Z-transforms
CO4	**Analyze** the probability models arising in the engineering field using basic concepts of probability, random variables and probability distributions.
CO5	**Apply** statistical methodology and tools in the engineering problem-solving process.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.
3. Glyn James, Advanced modern Engineering Mathematics, Pearson Publications, 4 ED., 2011
4. Peter v. O'neil, advanced Engineering Mathematics, Cengage learning, 7th ed., 2012.
5. H. C. Taneja, Advanced Engineering Mathematics, Volume I & II, I.K. International Publishing House Pvt. Ltd., New Delhi.

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. C. Ray Wylie, Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill Book Co., New York, 6th Ed., 2017.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand Publication, 3rd Ed., 2014.

Web links and Video Lectures (e-Resources)

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

IV Semester

Course Title	DISCRETE MATHEMATAL STRUCTURES							
Course Code	22XXT405A							
Category	ESC							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	00	00	04	40	00	03
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**				

COURSE LEARNING OBJECTIVES

This course is proposed to enhance the student's ability to think logically, mathematically and algorithmically and use the concepts of discrete mathematical structures to solve problems connected to computer and information science & engineering.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Fundamentals of Logic:** Propositions-Logical Connectives, Tautologies, Contradictions. Logical Equivalence–The Laws of Logic, Inverse, Converse and Contrapositive. Logical Implication – Rules of Inference. Quantifiers and Types of Quantifiers. **Self-study:** Proofs of theorems - Method of direct and indirect proofs. **Applications:** Applications to Switching Networks. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**Set Theory and Mathematical Induction:** Sets, subsets, set operations, laws of set theory, counting and venn diagram. The well ordering principle, principle of mathematical induction, alternative form of mathematical induction. **Self-study:** Axioms of probability, **Applications:** Applications to recursive relations. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Relations and Functions:** Cartesian product, relations, Equivalence relation and partition. Partial order, Poset, Hasse diagram. Functions, one-one and onto functions, composition of a function and inverse functions. **Self study:** Pigonhole principle**,** Stirling numbers. **Applications:** Computer recognition-zero-one matrices and directed graphs. (RBT levels: **L1, L2, L3, L4**)	04	04
IV	**Introduction to Graph Theory:** Definition of a graph and examples. Degree of a vertex and degree sequence- Hakim's theorem(no proof). Standard graphs - complete graph, regular graph, Peterson graph, bipartite graph, complete bipartite graph. Compliment of a graph, self-complimentary graphs. Graph isomorphism. Sub graph- proper sub graph, spanning sub graph, induced sub graph. Walk, trial, path, cycle, connectedness, Euler and Hamiltonian graph. **Self-study:** Operation on graphs - union, intersection, ring sum, Cartesian product, deletion & addition of edge/vertex.	04	04

	Applications: Konigsberg bridge problem, Seating arrangement problem. (RBT levels: **L1, L2, L3, L4**)		
V	**Trees and Cut-sets:** Trees, Properties, Rooted Tree, Binary tree, Spanning Tree, Minimal Spanning Tree - Prism Algorithm Kruskal's Algorithm, Dijikstra's shortest path algorithm for directed and undirected graph. **Self-study:** Cut Set, Network Flow, Maximum Flow and Minimum cut Theorem. **Applications:** Prefix code: David Huffman Algorithm. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Demonstrate** the knowledge of fundamental concepts in discrete mathematics and graph theory.
CO2	**Apply** the concepts of logics, mathematical induction and set theory to solve domain specific problems.
CO3	**Analyze** the given problem to find the solution by suitable discrete mathematical concepts.
CO4	**Examine** the given concepts related to mapping and graph theory.
CO5	**Develop** a variety of algorithms using appropriate technology.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. Ralph P. Grimaldi: Discrete and Combinatorial Mathematics, 5th Edition, Pearson Education, 2004.
2. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science",Tata McGraw-Hill.
3. Introduction to graph theory by Gary Chartrand and Ping Zang, Tata McGraw-Hill addition 2006.

REFERENCE BOOKS

1. Narsingh Deo, Graph theory with applications to engineering and computer Science, PHI, 1979.
2. C L Lium& D P Mohapatra, Elements of Discrete Mathematics, A Computer Oriented Approach, The McGraw-Hill Companies.
3. Kenneth H. Rosen: Discrete Mathematics and its Applications, 6th Edition, McGraw Hill, 2007.
4. Graph theory with applications to engineering and computer Science by Narsingh Deo

Web links and Video Lectures (e-Resources)

1. https://onlinecourses.nptel.ac.in/noc20_cs82/preview
2. https://nptel.ac.in/courses/106108227
3. https://archive.nptel.ac.in/courses/111/106/111106102/
4. https://www.youtube.com/watch?v=sWsXBY19o8I
5. https://youtu.be/ZiojZJfQYh0

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

IV Semester

Course Title	METRIC SPACES							
Course Code	**22XXT405B**							
Category	**ESC**							
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	00	00	04	40	00	03
CIE Marks: 50	**SEE Marks: 50**		**Total Max. marks = 100**		**Duration of SEE: 03 Hours**			

COURSE LEARNING OBJECTIVES

This course is proposed to impart to the students the skills to develop the theory of metric spaces and apply the concepts in complex engineering problems.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Introduction to Metric spaces:** Set, operation on sets, Cartesian product of sets, Relation, Function, ordered sets, equivalent sets, sequences, field , linear space, Normed linear space, Euclidean space, Minkowski's inequality, Holder inequality, Topological space. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**Metric space:** Definition, Pseudo metric space, open ball, metric topology, Closed ball, Metric induced by norm, Neighborhood of a point, subspace of a metric space, Base of a metric space. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Bounded set:** Definition , Bounded metric space, Dense set, separable space, Nowhere dense set, equivalent matrices, Cartesian product of matrices. (RBT levels: **L1, L2, L3, L4**)	04	04
IV	**Completeness:** Convergent sequence, Cauchy sequence, complete metric space, Cantor's intersection theorem, category of a set, Baire category theorem. (RBT levels: **L1, L2, L3, L4**)	04	04
V	**Compactness and Connectedness:** Definition, Bolazno-Weistrass property, sequential compactness, Separated sets, connected metric space. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Learn** basic facts about the cardinality of a set and various set theoretic paradoxes.
CO2	**Recognize** open and closed spheres and bounded sets.
CO3	**Understand** several standard concepts of metric spaces and their properties

CO4	**Identify** the continuity of a function defines on metric spaces and homomorphism
CO5	**Analysis** compactness and connectedness of metric spaces.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. Parijat Sinha, Metric spaces, Kedarnath Ramnath, India, 2020.
2. E.T. Copson (1988). *Metric spaces*. Cambridge University Press
3. P.R. Halmos (1974). *Naive Set Theor*y. Springer
4. P.K. Jain & Khalil Ahamad (2019), *Metric Spaces*. Narosa

REFERENCE BOOKS

1. S. Kumaresan (2011). *Topology of Metric spaces* (2nd edition), Narosa
2. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
3. Micheal O;Searcoid (2009), Metric spaces. Springer-Verlag
4. G.F. Simmons (2004). Introduction to Topology and Modern analysis. McGraw-Hil

Web links and Video Lectures (e-Resources)

1. http://www.umsl.edu
2. http://www.waterstones.com

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

IV Semester

Course Title	ALGORITHMIC GAME THEORY						
Course Code	**22XXT405C**						
Category	**ESC**						
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total			
	02	02	00	00	04	40	00	03
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**				

COURSE LEARNING OBJECTIVES

This course is proposed to impart to the students the skills to develop the theory of games and working algorithms to solve complex engineering problems.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Basic Concepts and computational issues:** Assumption of Game theory, example of Game theory, equilibrium concepts, Nash equilibrium, Indifference principle, Security of players. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**Matrix Games:** Minmax theorem, implication of Minmax theorem, MSNE's of matrix games, iterative elimination of dominated strategies, Bress's paradox, Yao's Lemma and applications, support enumeration algorithm. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Computing Equilibrium:** Succinct game, potential games, best response dynamics, fast convergence of best response, PSNE's for conjunction and systematic conjunction games, PPAD class, Sperner lemma. Approximate MSNE computation, (RBT levels: **L1, L2, L3, L4**)	04	04
IV	**Correlated and Coarse Correlated Equilibrium:** correlated equilibrium, Coarse correlated equilibrium, external regret frame work, multiplicative weight algorithm, Swap regret and correlated equilibrium, Swap regret to external regret reduction, **Price of Anarchy:** BRAESS's paradox and Pigou's network, PoA of selfish routing algorithm, Bayesian game, BNE of first price action, extensive form game (RBT levels: **L1, L2, L3, L4**)	04	04
V	**Mechanism Design:** introduction, implementation of social choice functions, revelation principle, properties of social choice function, Gibbard-Satterthwait theorem. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Learn** the basic notions of game theory, matrix games, equilibria, strategic interaction.
CO2	**Understand** the notion of efficiency in games, Braess's paradox, Bayesian game.
CO3	**Know** how to implement algorithms for computing equilibria, correlated equilibria and swap regret.
CO4	**Understand** issues of strategic behaviour, correlated equilibrium and self-routing

	algorithms.
CO5	**Develop** mechanism design, social choice functions and apply Gibbard-Satterthwait theorem.

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. Nisan/Roughgarden/Tardos/Vazirani (eds), Algorithmic Game Theory, Cambridge University, 2007.
2. Michael Maschler, Eilon Solan, and Shmuel Zamir, Game Theory.
3. Y. Narahari, Game Theory and Mechanism Design.

REFERENCE BOOKS

1. Palash Dey, Lecture notes: Algorithmi Game Theory, Indian Institute of Technology, Kharagpur.
2. Sir Donald Buphet, Game Theory: The Everyday Guide,
3. Avinash K. Dixit, Barry J. Nalebuff, The Art of Strategy: A Game Theorist's Guide to Success in Business and Life, W. W Norton & Company., illustrated Ed., 2010.
4. Ivan Pastine, Tuvana Pastine, Tom Humberstone, Introducting game theory: A grahic guide, Icon books, 2017.

Web links and Video Lectures (e-Resources)

1. https://youtu.be/gsIulizlQJ4
2. https://archive.nptel.ac.in/courses/106/105/106105237/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056
Scheme of Teaching and Examinations – 2023
Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2023-24)

IV Semester

<table>
<tr><td>Course Title</td><td colspan="8">GRAPH THEORY AND NETWORKS</td></tr>
<tr><td>Course Code</td><td colspan="8">22XXU405D</td></tr>
<tr><td>Category</td><td colspan="8">ESC</td></tr>
<tr><td rowspan="3">Scheme and Credits</td><td colspan="5">Theory/Practical/Integrated</td><td rowspan="2">Total teaching hours</td><td rowspan="2">Lab slots</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>SDA</td><td>Total</td></tr>
<tr><td>02</td><td>02</td><td>00</td><td>00</td><td>04</td><td>40</td><td>00</td><td>03</td></tr>
<tr><td>CIE Marks: 50</td><td colspan="2">SEE Marks: 50</td><td colspan="2">Total Max. marks = 100</td><td colspan="4">Duration of SEE: 03 Hours</td></tr>
</table>

COURSE LEARNING OBJECTIVES

This course is proposed to impart to the students the skills to develop the graph algorithms, networks, and to apply the concepts in complex engineering problems.

<table>
<tr><th rowspan="2">Unit</th><th rowspan="2">Syllabus content</th><th colspan="2">No. of hours</th></tr>
<tr><th>Theory</th><th>Tutorial</th></tr>
<tr><td>I</td><td>Graph concepts: Definition of a graph and examples. Degree sequence - Hakim's theorem (no proof). Handshaking theorem. Standard graphs - complete graph, regular graph, Peterson graph, bipartite graph, complete bipartite graph. Subgraphs - proper subgraph, spanning subgraph, induced subgraph. Isomorphism of graphs. Walk, trial, path, cycle, connectedness, Euler and Hamiltonian graph
Self Study: Operation on graphs - union, intersection, ring sum, cartesian product, deletion & addition of edge/vertex, complement of a graph, self complimentary graph.
Applications: Konigsberg bridge problem, Seating arrangement problem.
(RBT levels: L1, L2, L3, L4)</td><td>04</td><td>04</td></tr>
<tr><td>II</td><td>Trees and Fundamental circuits: Definition of a tree, properties and examples. Types of trees - spanning tree, rooted tree, binary tree. Distance and centre. Fundamental circuits. Rank and Nullity.
Self Study: Line graph, middle graph, total graph and diagraphs.
Applications: Prefix code: David Huffman Algorithm.
(RBT levels: L1, L2, L3, L4)</td><td>04</td><td>04</td></tr>
<tr><td>III</td><td>Matrix representation and Planar graphs: Incidence matrix, adjacency matrix, path matrix, circuit matrix, fundamental circuit matrix. Planar graphs, Kuratowski’s graph, Kuratowski’s theorem, Euler’s polyhedral formula.
Self Study: Incidence and adjacency matrix of diagraphs.
Applications: Detection of planarity using elementary reduction method
(RBT levels: L1, L2, L3, L4)</td><td>04</td><td>04</td></tr>
<tr><td>IV</td><td>Graph coloring and Networks: Vertex coloring, chromatic number, chromatic polynomial, matching, covering, Independent set, domination. Four coloring problem. Cut set, cut vertex, vertex connectivity, edge connectivity, blocks in separable graphs.
Self Study: Five coloring problem.</td><td>04</td><td>04</td></tr>
</table>

	Applications: Simplification of Boolean expression. Network flow, Maximum flow and minimum cut theorem. (RBT levels: **L1, L2, L3, L4**)		
V	**Graph Algorithms:** Dijikstra's shortest path algorithm for directed and undirected graph. Minimal spanning tree algorithm: Kruskal and Prism algorithm. Cyclic exchange algorithm to find all spanning trees. **Self Study:** Algorithm for connectedness. **Applications:** Travelling salesman problem - nearest neighbourhood method. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Demonstrate** the knowledge of fundamental concepts in graph theory.
CO2	**Apply** the concepts of graph theory to solve domain specific problems.
CO3	**Analyze** and find the solution by suitable graph theoretical concepts.
CO4	**Examine** for the existence of graph structures by suitable graph algorithms, tree structures, planarity.
CO5	**Develop** a variety of algorithms using appropriate technology

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. Gary Chartrand and Ping Zang, Introduction to graph theory, Tata McGraw-Hill addition 2006.
2. Narsingh Deo, Graph theory with applications to engineering and computer Science, PHI, 1979.
3. F. Harary, Graph theory, Narosa publishing house, New Delhi, 2013.

REFERENCE BOOKS

1. Geir Agnarsson and Raymond Greenlaw, Graph theory-Modeling, application and Algorithm, Pearson publications, 1998
2. John Clark, Derem Allan Hollon, Graph theory, Allied Publishers, 1995.

Web links and Video Lectures (e-Resources)

1. **https://archive.nptel.ac.in/courses/111/106/111106102/**
2. **https://www.youtube.com/watch?v=sWsXBY19o8I**
3. **https://youtu.be/ZiojZJfQYh0**

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	3	2										
CO3	2	3										
CO4	3	2										
CO5	2	3										
Strength of correlation: Low-1, Medium-2, High-3												

Dr. Ambedkar Institute of Technology, Bengaluru-560056

Scheme of Teaching and Examinations – 2023

Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

IV Semester

Course Title	**OPTIMIZATION TECHNIQUE**						
Course Code	**22XXU405E**						
Category	**ESC**						
Scheme and Credits	Theory/Practical/Integrated				Total teaching hours	Lab slots	Credits
	L	T	P	SDA	Total		
	02	02	00	00	04	40	00	03
CIE Marks: 50	**SEE Marks: 50**	**Total Max. marks = 100**		**Duration of SEE: 03 Hours**			

COURSE LEARNING OBJECTIVES

This course is proposed to impart to the students the skills to develop the theory of operations research and to obtain optimal solutions for complex engineering problems.

Unit	Syllabus content	No. of hours	
		Theory	Tutorial
I	**Operations Research:** phases, characteristics and limitations, models used in operations research. **Linear Programming Problem:** Definition, Convexity and Basic Feasible Solutions. Formulation and examples, Graphical Solution, Convex and polyhedral sets, Extreme points, Basic solutions, Basic feasible solutions, Correspondence between basic feasible solutions and extreme points. **Self-study:** Computer solution with excel solver and AMPL, Production model, elementary models, bus scheduling model. (RBT levels: **L1, L2, L3, L4**)	04	04
II	**The Simplex method and Sensitivity Analysis** Linear programming model in equation form, transition from graphical to algebraic solution. Simplex method, Canonical and Standard form of Linear programming problem, Optimality criterion, slack and surplus variables, Solutions to LPP by simplex method, Artificial variable, penalty method and two-phase simplex method. **Self-Study:** Degeneracy in LPP. (RBT levels: **L1, L2, L3, L4**)	04	04
III	**Duality and Post-optimal Analysis** Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory. Post-optimal analysis: changes affecting feasibility and optimality. **Self-study:** Solving LPP by Generalized simplex method. (RBT levels: **L1, L2, L3, L4**)	04	04
IV	**Transportation Problem :** Formulation, methods of finding initial basic feasible solutions: North-west corner rule, Least-cost method, Vogel approximation method, Algorithm for obtaining optimal solution using MODI method. **Assignment Problem:** Formulation, Hungarian method. **Self-study:** Travelling sales man problem.	04	04

	(RBT levels: **L1, L2, L3, L4**)		
V	**Integer Linear Programming** Illustrative applications, integer programming algorithm: branch and bound algorithm, cutting plane algorithm. **CPM and PERT:** Introduction, limitations, applications, basic steps, frame works, network diagram and rules, common errors in drawing a network, critical path in network analysis, PERT. (RBT levels: **L1, L2, L3, L4**)	04	04

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1	**Understand** the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	**Apply** Simplex methods and determine optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
CO3	**Formulate** as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
CO4	**Analyze** integer linear programming problems and solve.
CO5	**Construct** network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks

TEACHING – LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

TEXTBOOKS

1. Hamdy A. Taha, Operations Research-An Introduction, Seventh Edition, , PHI, 2006.
2. S.D.Shama, Operations Research-Theory, methods and applications, Laxmi Publicaitons, 2009.
3. P.K.Gupta and D.S.Hera, Operations Research, S.Chand New Delhi, 2009

REFERENCE BOOKS

1. B. S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.

Web links and Video Lectures (e-Resources)

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
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