BMS COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

DEPARTMENT OF MATHEMATICS

SYLLABUS (2021 - 2022)

FIRST SEMESTER B.E.

Course Title	**Calculus and Differential Equations**	**Course Code**	**21MA1BSCDE**
Credits	**03**	**L – T – P**	**2 – 1 – 0**

Course Objectives: The goal of the course Calculus and Differential Equations is

- To facilitate the students with a concrete foundation of differential calculus & analytical methods for ordinary differential equations, required for solving engineering problems.
- To enable the students to apply linear algebra to solve engineering problems.

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.

UNIT-1

DIFFERENTIAL CALCULUS – 1 **[08 hours]**

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

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

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-2

DIFFERENTIAL CALCULUS – 2 **[08 hours]**

Taylor's and Maclaurin's series expansion for one variable (Statement only) – problems. Partial differentiation, total derivative-differentiation of composite functions. Jacobian and problems. Maxima and minima for a function of two variables. Problems.

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

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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UNIT-3

LINEAR ALGEBRA **[08 hours]**

Elementary row transformation of a matrix, Rank of a matrix. Consistency and Solution of system of linear equations; Gauss-elimination method and Approximate solution by Gauss-Seidel method. Eigenvalues and Eigenvectors, Rayleigh's power method to find the dominant Eigenvalue and Eigenvector.

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

(RBT Levels: L1, L2 and L3).

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-4

ORDINARY DIFFERENTIAL EQUATIONS (ODE's) OF FIRST ORDER **[08 hours]**

Bernoulli's differential equations. Exact and reducible to exact differential equations. Applications of ODE's - Orthogonal trajectories.

Nonlinear differential equations: Introduction to general and singular solutions; Solvable for p only; Clairaut's equations, reducible to Clairaut's equations. Problems.

Self-Study: Applications of ODE's: L-R circuits. Solvable for x and y.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-5

ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER **[08 hours]**

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

Self-Study: Applications to oscillations of a spring and L-C-R circuits.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

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Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO
21MA1BSCDE	CO 1	Understand and Apply the concepts of calculus and linear algebra.	1
	CO 2	Demonstrate the importance of calculus and linear algebra through solving mathematical problems.	9, 12
	CO 3	Engage in independent study as a member of a team to make presentations on an application of mathematical concepts for society.	6, 9, 10 &12

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Presentation	10	100	05	50
	Assignment	10		05	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 1, 3, 5 and two questions each from Unit 2 and Unit 4.

Suggested Learning Resources:

Text Books

1. **B. S. Grewal:** "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018.
2. **E. Kreyszig:** "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

Reference Books

1. **B.V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal & Subodh C. Bhunia:** "Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.
3. **N. P. Bali and Manish Goyal:** "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co. Newyork, Latest ed.
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 (2014).
7. **James Stewart: "**Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

Web links and Video Lectures (e-Resources):

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

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SYLLABUS (2021 - 2022)

SECOND SEMESTER B.E.

Course Title	**Advanced Calculus and Numerical Methods**	**Course Code**	**21MA2BSACN**
Credits	**03**	**L – T – P**	**2 – 1 – 0**

Course Objectives: The goal of the course Advanced Calculus and Numerical Methods is

- To facilitate the students with a concrete foundation of integral calculus.
- To facilitate the students with a concrete foundation of vector calculus, partial differential equations and numerical methods enabling them to acquire the knowledge of these mathematical tools.

Teaching-Learning Process (General Instructions):

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples
3. Support and guide the students for self-study.

UNIT-1

INTEGRAL CALCULUS **[08 hours]**

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 of polar curves and Volume by a triple integrals. Problems.

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

Self-Study: Mass and density.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-2

VECTOR CALCULUS **[08 hours]**

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. Statement of Green's theorem and Stokes theorem. Problems.

Self-Study: Volume integral and Gauss divergence theorem.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-3

PARTIAL DIFFERENTIAL EQUATIONS (PDE's) **[08 hours]**

Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Solution of PDE by the method of separation of variables. Solution of Lagrange's linear PDE. Derivation of one-dimensional heat equation and wave equation.
Self-Study: Solution of one-dimensional heat equation and wave equation by the method of separation of variables.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

UNIT-4

NUMERICAL METHODS -1 **[08 hours]**

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

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

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

UNIT-5

NUMERICAL METHODS -2 **[08 hours]**

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, Milne's predictor-corrector formula (No derivations of formulae). Problems.

Self-Study: Adam-Bashforth method.

Teaching-Learning Process	Chalk and talk method/PowerPoint Presentation

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Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

COURSE CODE	CO	COURSE OUTCOME (CO)	PO
21MA2BSACN	CO 1	Understand and Apply the concepts of multivariable calculus and numerical methods	1
	CO 2	Demonstrate the importance of multivariable calculus and numerical methods through solving mathematical problems.	9, 12
	CO 3	Demonstrate the concepts of numerical methods using mathematical programing tools.	5, 9, 10 & 12

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	AAT	10	100	05	50
	Assignment	10		05	
	Test 1	40		20	
	Test 2	40		20	
	Test 3	40		20	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from units 3, 4, 5 and two questions each from Unit 1 and Unit 2.

Suggested Learning Resources:

Text Books

1. **B. S. Grewal:** "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018.
2. **E. Kreyszig:** "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

Reference Books

1. **B.V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal & Subodh C. Bhunia:** "Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal:** "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co. Newyork, Latest ed.
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 (2014).
7. **James Stewart: "**Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

Web links and Video Lectures (e-Resources):

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

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SYLLABUS (2019 - 2020)

THIRD SEMESTER B.E COURSE
(Common to AS/CV/EEE/ECE/EIE/IEM/ME/ML/TCE)

Course Title	**Engineering Mathematics - 3**	**Course Code**	**19MA3BSEM3**
Credits	**04**	**L – T – P**	**3 - 1 - 0**
Contact hours	**48 hours**		

Prerequisites: Basic concepts of Trigonometry, methods of differentiation, methods of integration, solution of ordinary differential equations.

Course Objectives: The purpose of the course is to make the students conversant with concepts of Linear Algebraic systems, Fourier series, Fourier Transforms and develop computational skills using efficient numerical methods for problems arising in science and engineering.

UNIT-1

MATRICES **[9 hours]**

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method, LU decomposition method, eigenvalues and eigenvectors of matrices, reduction of a matrix to diagonal form. **(7L + 2T)**

UNIT-2

FOURIER SERIES **[9 hours]**

Introduction: Dirichlet's conditions, Fourier series of periodic functions of period $2l$, Fourier series of functions having points of discontinuity. Applications: Fourier series of typical waveforms like saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform, exponential Fourier series, practical harmonic analysis. **(7L + 2T)**

UNIT-3

FOURIER TRANSFORMS **[9 hours]**

Infinite Fourier transform: Fourier Sine and Cosine transforms, properties, Inverse transforms. Convolution theorem, Parseval's identities. **(6L + 3T)**

UNIT-4

NUMERICAL METHODS **[10 hours]**

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

Finite Differences and interpolation: Forward differences, backward differences. Newton- Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule, Weddle's rule.

Numerical solution of ordinary differential equations: modified Euler's method, Runge-Kutta method of fourth order**.** **(8L + 2T)**

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UNIT-5

CALCULUS OF VARIATIONS **[11 hours]**

Variation of a functional, Euler's equation, variational problems.

Applications: Hanging cable problem, Brachistochrone problem.

Z -TRANSFORMS

Definition, Properties, Transforms of standard functions, Inverse transforms. Solution of difference equations using Z- transforms. **(8L + 3T)**

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
19MA3BSEM3	CO 1	Apply Numerical techniques to solve problems arising in engineering.	1
	CO 2	Demonstrate an understanding of Fourier Series, Fourier Transforms and Z- Transforms.	
	CO 3	Apply the concepts of calculus to functionals.	

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Advanced Engineering Mathematics, 4th edition, 2011, Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

Reference Books:

1. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.

E books and online course materials:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/lecture-notes/
2. https://www.pdfdrive.com/calculus-of-variations-e34313748.html

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111103021/22 (Fourier series and Transforms, Heat and Wave Equations)
2. https://nptel.ac.in/courses/122104018/2 (Numerical Methods)
3. https://nptel.ac.in/courses/111104025/ (Calculus of variation)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question each from units 1, 2, 4 and two questions each from Unit 3 and Unit 5.

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SYLLABUS (2019 - 2020)

THIRD SEMESTER B.E COURSE
(CSE/ISE)

Course Title	**Statistics and Discrete Mathematics**	**Course Code**	**19MA3BSSDM**
Credits	**04**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours (36L+12T)**		

Prerequisites: Basic Concepts of Probability and Statistics.

Course Objectives: To acquaint the student with various concepts of discrete mathematics, Probability, Statistics and Queuing required in several streams of Computer/Information Science.

UNIT-1

GRAPH THEORY **[11 hours]**

Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonian graphs, sub-graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix. Trees: spanning tree, minimal spanning tree: Kruskal's algorithm, Prim's algorithm, shortest path-Dijkstra's algorithm.

(8L+3T)

UNIT-2

COMBINATORICS **[9 hours]**

Principles of counting: The rules of sum and product, permutations. Combinations- Binomial and multinomial theorems. Catalan numbers, the principle of inclusion and exclusion. Derangements.

(7L+2T)

UNIT-3

PROBABILITY **[8 hours]**

Theoretical distributions: Poisson distribution, Exponential and Normal distributions.

Joint probability distributions: Discrete random variable, Mathematical expectations, Covariance and Correlation. **(6L+2T)**

UNIT-4

STATISTICAL INFERENCE **[11 hours]**

Introduction, procedure for testing of hypothesis, level of significance.

[Large sample] Test of significance for single mean, difference between two means, single proportion, difference between two proportions.

[Small sample] Test of significance for single mean, difference between two means, paired t-test, ratio of variances (F- distribution), Chi-Square distribution-goodness of fit.

(8L+3T)

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UNIT-5

MARKOV CHAIN AND QUEUING THEORY **[9 hours]**

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chains. Queuing models: Concept of Queue, M/M/1 queuing systems. **(7L+2T)**

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On completion of the course student will have the ability to:

Course Code	CO #	COURSE OUTCOMES (CO)	PO
19MA3BSSDM	CO 1	Use graphs as representation tool in network analysis	1
	CO 2	Demonstrate an understanding of the basic concepts of Combinatorics.	
	CO 3	Apply the concepts for probability, Statistics and Queuing theory.	

Text Books:

1. Discrete Mathematics, Seymour Lipchitz. M. Lipson, 2005, Tata McGraw Hill.
2. Graph Theory and Combinatorics, D. S. Chandrasekharaiah, 4th edition, 2011-12, Prism Engineering Education Series.
3. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

Reference Books:

1. Discrete Mathematics and its Applications, Kenneth H. Rosen, 2002, McGraw Hill.
2. Discrete Mathematics, Kolman, Busby Ross, 5th edition, 2004, Prentice Hall.
3. Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo, Eastern Economy Edition, PHI Learning Pvt., Ltd.

E books and online course materials:

1. http://jlmartin.faculty.ku.edu/~jlmartin/courses/math725-S16/
2. https://www.whitman.edu/mathematics/cgt_online/cgt.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/probability-intro
2. https://nptel.ac.in/courses/111104026/ (Discrete Mathematics)
3. https://nptel.ac.in/courses/111106086/ (Combinatorics)
4. https://nptel.ac.in/courses/111102112/ (Statistical Inference)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question in Units 2, 3, 5 and two questions each in unit 1 and unit 4.

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SYLLABUS (2021 - 2022)

THIRD SEMESTER B.E COURSE
(CHEMICAL ENGINEERING)

Course Title	**Applied Mathematics**	**Course Code**	**21MA3BSAPM**
Credits	**03**	**L – T – P**	**3 – 0 – 0**
Contact hours	**39 hours**		

Prerequisites: Basic concepts of Trigonometry, methods of differentiation, methods of integration, solution of ordinary differential equations.

Course Objectives: The purpose of the course is to make the students conversant with concepts of Fourier Series, Fourier Transforms, extremal of functionals and develop computational skills using efficient numerical methods for problems arising in science and engineering.

UNIT-1

MATRICES **[08 hours]**

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices.

UNIT-2

NUMERICAL METHODS **[08 hours]**

Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation: Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule.

Numerical solution of ordinary differential equations: Runge-Kutta method of fourth order.

UNIT-3

FOURIER SERIES **[08 hours]**

Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period $2l$, Fourier series of functions having points of discontinuity.

FOURIER TRANSFORMS

Infinite Fourier transform, Fourier sine and cosine transforms, Inverse transforms.

UNIT-4

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **[08 hours]**

Finite-Difference formulas to partial derivatives.

Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

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UNIT- 5

CALCULUS OF VARIATIONS **[07 hours]**

Variation of a functional, Euler's equation, variational problems.

Applications: Geodesic on a plane, minimal surface of revolution, hanging cable problem, Brachistochrone problem.

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
21MA3BSAPM	CO 1	Apply Numerical techniques to solve problems arising in engineering.	1
	CO 2	Demonstrate an understanding of Fourier Series and Fourier Transforms.	
	CO 3	Apply the concepts of calculus to functionals.	

Text Books:

1. Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Advanced Engineering Mathematics, Dennis G. Zill and Cullen, 4th edition, 2011, Jones and Bartlett India Pvt. Ltd.

Reference Books:

1. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.
2. Numerical methods for Engineers, R. P. Canale and S. C. Chapra, 7th edition, McGraw Hill Education India Private Ltd.

E books and online course materials:

1. https://www.math.ubc.ca/~peirce/M257_316_2012_Lecture_8.pdf
2. https://www.pdfdrive.com/calculus-of-variations-e34313748.html

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111103021/22 (Fourier series and Transforms, Heat and Wave Equations)
2. https://nptel.ac.in/courses/122104018/2 (Numerical Methods)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question from Units 1, 4, 5 and two questions from Unit 2 and Unit 3.

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SYLLABUS (2021 - 2022)

THIRD SEMESTER B.E. COURSE
(AI & ML)

Course Title	**Mathematical Foundations for AI & ML**	**Course Code**	**21MA3BSMAI**
Credits	**04**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours**		

Prerequisites: Basic concepts of Permutations, Combinations, Mathematical Induction, G.C.D., L.C.D., divisors and primes.

Course Objectives: To acquaint the student with various concepts of Permutations, Combinations, Generating Fucntions and Congruences.

UNIT-1

GRAPH-THEORY-1: [08+02 hours]

Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonian graphs, sub-graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix.

UNIT-2

GRAPH THEORY-2: [06+02 hours]

Trees: spanning Trees: minimal spanning tree: Kruskal's algorithm, Prim's algorithm, Network flows, DFS, BFS, shortest path-Dijkstra's algorithm.

UNIT-3

COMBINATORICS: [08 +02 hours]

Introduction - The rules of sum and product, Pigeonhole principle, permutations, Combinations, Binomial and multinomial theorems. Catalan numbers, the principle of inclusion and exclusion, Derangements, Rook Polynomials, Generating functions.

UNIT-4

INDUCTION AND RECURRENCE RELATIONS: [07+03 hours]

Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, First order recurrence relations, second-order homogeneous recurrence relations, third order linear homogeneous recurrence relations.

UNIT-5

CONGRUENCES AND ITS APPLICATIONS : [07+03 hours]

Introduction to Congruences, Linear Congruences, The Chinese Remainder Theorem, Solving Polynomials, Liner Diophantine Equation, System of Linear Congruences, Euler's Theorem, Willson's Theorem and Fermat's little Theorem, Applications of Congruences – RSA algorithm.

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
21MA3BSMAI	CO 1	Utilize graphs as representation tool in optimization techniques.	1,5
	CO 2	Demonstrate the applications of Combinatorics, Mathematical Induction, Recurrence relations and generating functions.	
	CO 3	Apply the concepts of congruence's to various applications.	

Text Books:

1. Kenneth H.Rosen, Discrete Mathematics and its applications, 7th edition, McGraw Hill Publishers
2. Dr. D.S.C, Graph Theory and Combinatorics, 4th edition, Prism engineering education series

Reference Books:

1. Kenneth H.Rosen, Elementary number theory and its applications, 5th edition, Pearson publications
2. Discrete Mathematics, Kolman, Busby Ross, 5th edition, 2004, Prentice Hall.
3. Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo, Eastern Economy Edition, PHI Learning Pvt., Ltd.

E books and online course materials:

1. http://jlmartin.faculty.ku.edu/~jlmartin/courses/math725-S16/
2. https://www.whitman.edu/mathematics/cgt_online/cgt.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/probability-intro
2. https://nptel.ac.in/courses/111104026/ (Discrete Mathematics)
3. https://nptel.ac.in/courses/111106086/ (Combinatorics)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question in Units 1, 2, 5 and two questions each in unit 3 and unit 4.

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SYLLABUS (2019 - 2020)

THIRD SEMESTER B.E COURSE

(Common to All Branches)

Course Title	**Additional Mathematics-I**	**Course Code**	**19MA3IMMAT**
Credits	**00**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours (36L+12T)**	**III semester Lateral Entry students**	

Prerequisites: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

Course Objectives: To provide students with a solid foundation in mathematical fundamentals such as differentiation, differential equations, vectors and orthogonal curvilinear coordinates for different branches of engineering.

UNIT 1

DIFFERENTIAL AND INTEGRAL CALCULUS [9 Hours]

List of standard derivatives including hyperbolic functions, rules of differentiation. Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems. **(7L+2T)**

UNIT 2

POLAR COORDINATES AND PARTIAL DERIVATIVES [10 Hours]

Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Jacobians and their properties (without proof) – Problems. **(7L+3T)**

UNIT 3

VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES [10 Hours]

Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in orthogonal curvilinear coordinates. **(7L+3T)**

UNIT 4

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS [9 Hours]

Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories.

(7L+2T)

UNIT 5

SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS [10 Hours]

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type $f(x) = e^{ax}$, $\sin(ax)$, $\cos(ax)$, x^n, method of variation of parameters, Cauchy's and Legendre linear differential equations.

(8L+2T)

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On completion of the course, students will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
19MA3IMMAT	CO 1	Understand the basic concepts of differentiation and integration.	1
	CO 2	Apply the concepts of polar curves and multivariate calculus.	
	CO 3	Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.	
	CO 4	Apply techniques of vector calculus to engineering problems.	
	CO 5	Comprehend the generalization of vector calculus in curvilinear coordinate system.	

Text Book:

1. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2014, Khanna Publishers
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

Reference Book:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

E books and online course materials:

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
2. http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
3. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
4. http://ocw.mit.edu/courses/mathematics/ (online course material)

Online Courses:

1. https:// www.khanacademy.org/Math
2. https:// www.class-central.com/subject/math (MOOCS)

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DEPARTMENT OF MATHEMATICS

SYLLABUS (2019 - 2020)

FOURTH SEMESTER B.E COURSE
(Common to AS/CV/EEE/ECE/EIE/ML/TCE)

Course Title	**Engineering Mathematics - 4**	**Course Code**	**19MA4BSEM4**
Credits	**04**	**L – T – P**	**3 -1- 0**
Contact hours	**48 hours**		

Prerequisites: Complex numbers, multivariate calculus and basic concepts of Statistics and Probability.

Course Objectives: To prepare students with adequate knowledge in Probability and Statistics, Complex Analysis and develop computational skills using efficient numerical methods for problems in science and engineering.

UNIT-1

STATISTICS AND PROBABILITY **[10 hours]**

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression. Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution- Normal distribution.

(8L + 2T)

UNIT-2

JOINT PROBABILITY AND MARKOV CHAIN **[9 hours]**

Joint Probability Distributions:

Discrete random variables, Mathematical expectations, Covariance and Correlation.

Markov Chain:

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain.

(7L + 2T)

UNIT-3

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **[9 hours]**

Finite-Difference formulas to partial derivatives.

Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme. **(7L + 2T)**

UNIT-4

COMPLEX ANALYSIS – 1 **[10 hours]**

Functions of a complex variable, limits, continuity and differentiability of a complex valued function, Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method.

Conformal mapping: $w = z^2$ and $w = z + \frac{a^2}{z}\left(z \neq 0\right)$. Bilinear transformations. **(7L + 3T)**

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UNIT-5

COMPLEX ANALYSIS - 2 **[10 hours]**

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.

Complex series: Taylor's, Maclaurin's and Laurent's series (without proof)-examples.

Zeros, Poles and Residues, Cauchy's residue theorem (without proof)-examples. **(7L + 3T)**

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOMES (CO)	PO
19MA4BSEM4	CO 1	Demonstrate an understanding of concepts of statistical analysis and probability distributions.	1
	CO 2	Apply Numerical techniques to solve partial differential equations arising in engineering.	
	CO 3	Demonstrate an understanding of analytic functions and their application to evaluate integrals.	

Text Books:

1. Numerical Methods for Engineering, R. P. Kanale and S. C. Chapra, 6th edition, McGraw Hill, Publishers.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2013, Khanna Publishers.

E books and online course materials:

1. https://www.coursera.org/learn/basic-statistics
2. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook
3. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-variable-fall-2008/lecture-notes/
4. https://www.math.ubc.ca/~peirce/M257_316_2012_Lecture_8.pdf

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111105090/ (Probability & statistics-Joint distribution, testing of hypothesis)
2. https://nptel.ac.in/courses/111103070/ (Complex Analysis - Analytic functions, Mobius transformation & Residue theorem)
3. https://nptel.ac.in/courses/111107056/ (Complex Analysis - Complex integration, conformal mapping)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question in Units 1, 2, 3 and two questions each in unit 4 and unit 5.

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SYLLABUS (2019 - 2020)

FOURTH SEMESTER B.E COURSE - (CSE/ISE)

Course Title	**Linear Algebra**	**Course Code**	**19MA4BSLIA**
Credits	**04**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours (36L+12T)**	**CS/IS Cluster**	

Prerequisites: Vector Algebra, Matrix computations, Calculus, Geometry, Group Theory.

Course Objectives: To provide the students with a foundation of concepts in linear algebra that is essential to engineers of computer and information science.

UNIT-1

SYSTEM OF LINEAR EQUATIONS AND VECTOR SPACES [11 hours]

Elementary row operations, echelon forms, rank of matrix.

System of Linear Equations: solution of homogeneous equations, consistency of non-homogeneous system of linear equations. Gauss elimination method, LU decomposition method.

Vector spaces: Subspaces, Linear Combinations, Linear Spans, row space and column space of a Matrix, Linear Dependence and Independence, Basis and Dimension, Coordinates.

(9L+2T)

UNIT-2

LINEAR TRANSFORMATIONS [9 hours]

Introduction, Linear Mappings, Geometric linear transformation of $\mathbb{R}^2$, Kernel and Image of a linear transformations, Matrix representation of linear transformations, Rank-Nullity Theorem(No proof), Singular and Nonsingular linear transformations, Invertible linear transformations. **(7L+2T)**

UNIT-3

EIGENVALUES AND EIGENVECTORS [10 hours]

Introduction, Polynomials of Matrices, Characteristic polynomial, Cayley-Hamilton Theorem, eigenvalues and eigenvectors, eigen spaces of a linear transformation, Diagonalization, Minimal Polynomial, Characteristic and Minimal Polynomials of Block Matrices, Jordan Canonical form, Solving differential equations in Fundamental form. **(7L+3T)**

UNIT-4

INNER PRODUCT SPACES [10 hours]

Inner product, inner product spaces, length and orthogonality, orthogonal sets and Bases, projections, Gram-Schmidt process, QR-factorization, least squares problem and least square error. **(7L+3T)**

UNIT-5

SYMMETRIC MATRICES AND QUADRATIC FORMS [8 hours]

Diagonalization of real symmetric matrices, Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, Singular value decomposition.

(6L+2T)

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On completion of the course, student will have the ability to:

Course Code	CO #	Course Outcome (CO)	PO
19MA4BSLIA	CO 1	Apply the concepts of Matrices to linear systems and Vectors spaces.	1
	CO 2	Relate the concepts of Eigen values, Eigen vectors & functions to linear algebra.	
	CO 3	Apply the concepts of inner products to matrix decomposition.	

Text Books:

1. Linear Algebra and its applications, David C. lay, Steven R. lay, Judi J Mc. Donald, 5th Edition, 2015, Pearson Education.
2. Linear Algebra and its applications, Gilbert Strang, 4th edition, 2005, Brooks Cole.

Reference Books:

1. Schaum's outline series-Theory and problems of linear algebra, Seymour Lipschutz, 5th edition, 2012, McGraw-Hill Education.
2. Linear Algebra an Introduction, Richard Bronson & Gabriel B. Costa, 2nd edition.

E books and online course materials:

1. https://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/index.htm
2. https://www.math.ucdavis.edu/~linear/linear.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/linear-algebra-machine-learning
2. https://nptel.ac.in/syllabus/111106051/

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question each in Units 2, 4, 5 and two questions each in Unit 1 and Unit 3.

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SYLLABUS (2019 - 2020)

FOURTH SEMESTER B. E. COURSE - (CHEMICAL ENGINEERING)

Course Title	Statistics and Probability	Course Code	19MA4BSSAP
Credits	03	L – T – P	3 – 0 – 0
Contact hours	36 hours		

Prerequisites: Basic concepts of Statistics and Probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution. Basic concepts of statistics. Matrices.

Course Objectives: Student will get acquainted with the procedure of collecting, designing, analysing and drawing inference about the data

UNIT-1

STATISTICS & PROBABILITY **[7 hours]**

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression.

Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution- Normal distribution.

UNIT-2

JOINT PROBABILTY AND MARKOV CHAIN **[7 hours]**

Joint Probability Distributions:

Discrete random variables, Mathematical expectations, Covariance and Correlation.

Markov Chain:

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain.

UNIT-3

DESIGN OF EXPERIMENTS **[7 hours]**

Principles of experimental design – Randomization, Replication, Local Control.

Randomized block design, Completely Randomized block design, Latin Square Design, Factorial Experiments –Problems.

UNIT-4

STATISTICAL INFERENCE – I **[8 hours]**

Introduction, estimation – point, interval; procedure for testing of hypothesis, level of significance, construction of confidence interval.

[Large sample] Test of significance for single mean, difference between two means, single proportion, difference between two proportions, and difference of two Standard deviations for the biological data sets.

UNIT-5

STATISTICAL INFERENCE – II **[7 hours]**

[Small sample] Test of significance for single mean, difference between two means, paired t-test, ratio of variances (F- distribution), Chi -Square distribution-goodness of fit, independence of attributes. Analysis of variance (one-way and two-way classifications).

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On Completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
19MA4BSSAP	CO 1	Appreciate the use of Statistical methods to Analyze and interpret the data from real world examples.	1,2,9,10
	CO 2	Apply the basic principles of probability and Probability distributions to the problems in Engineering.	1,2
	CO 3	Apply the concepts of Markov chain to the field of genetics.	1,2
	CO 4	Demonstrate an understanding of sampling distributions and principles of experimental design.	1,2

Text Books:

1. Fundamentals of Biostatistics, Khirfan A. Khan, Atiya Khanum, 3rd edition, 2012, Ukaaz Publications.
2. An Introduction to Biostatistics, P. S. S. Sundar Rao and J. Richard, 4th edition, 2006, Prentice Hall of India.

Reference Books:

1. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th edition, Wiley.
2. Biostatistics, P. N. Arora, P. K. Malhan, 2nd edition, 2013, Himalaya Publishing House.

E books and online course materials:

1. https://www.coursera.org/learn/basic-statistics
2. https://www.coursera.org/learn/probability-intro
3. https://www.classcentral.com/course/udacity-intro-to-statistics-361
4. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook

Online Courses and Video Lectures:

1. http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics- spring-2014/
2. http://nptel.ac.in/courses/*111105041/1* NPTEL >> Mathematics >> Probability and Statistics
3. https:// www.khanacademy.org/Math
4. https:// www.class-central.com/subject/math (MOOCS)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question from Units 2, 3, 4 and two questions from Unit 1 and Unit 5.

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SYLLABUS (2019 - 2020)

FOURTH SEMESTER B.E COURSE
(BIOTECHNOLOGY)

Course Title	**Biostatistics and Probability**	**Course Code**	**19MA4BSBSP**
Credits	**04**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours (36L+12T)**		

Prerequisites: Basic concepts of Statistics and Probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution. Basic concepts of statistics. Matrices.

Course Objectives: Student will get acquainted with the procedure of collecting, designing, analysing and drawing inference about the data.

UNIT-1

STATISTICS & PROBABILITY **[11 hours]**

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression.

Discrete distribution: Poisson distribution, Continuous distributions: Normal and Gamma distributions. **(8L+3T)**

UNIT-2

JOINT PROBABILTY AND MARKOV CHAIN **[8 hours]**

Joint Probability Distributions:

Discrete random variables, Mathematical expectations, Covariance and Correlation.

Markov Chain:

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain.

(6L+2T)

UNIT-3

DESIGN OF EXPERIMENTS **[9 hours]**

Principles of experimental design – Randomisation, Replication, Local Control.

Randomised block design, Completely Randomised block design, Latin Square Design, Factorial Experiments, Plackett Burman Design. **(7L+2T)**

UNIT-4

STATISTICAL INFERENCE – I **[9 hours]**

Introduction, estimation – point, interval; procedure for testing of hypothesis, level of significance, construction of confidence interval.

[Large sample] Test of significance for single mean, difference between two means, single proportion, difference between two proportions, and difference of two Standard deviations for the biological data sets. **(7L+2T)**

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UNIT-5

STATISTICAL INFERENCE – II **[11 hours]**

[Small sample] Test of significance for single mean, difference between two means, paired t-test, ratio of variances (F- distribution), Chi -Square distribution-goodness of fit, independence of attributes. Analysis of variance (one-way and two-way classifications). Non parametric test – Kruskal – Wallis One Way Analysis of Variance by Ranks for the biological data sets.

(8L+3T)

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On Completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
19MA4BSBSP	CO 1	Appreciate the use of Statistical methods to Analyze and interpret the data from real world examples.	1,2,9,10
	CO 2	Apply the basic principles of probability and Probability distributions to the problems in Engineering.	1,2
	CO 3	Apply the concepts of Markov chain to the field of genetics.	1,2
	CO 4	Demonstrate an understanding of sampling distributions and principles of experimental design.	1,2

Text Books:

1. Fundamentals of Biostatistics, Khirfan A. Khan, Atiya Khanum, 3rd edition, 2012, Ukaaz Publications.
2. An Introduction to Biostatistics, P. S. S. Sundar Rao and J. Richard, 4th edition, 2006, Prentice Hall of India.

Reference Books:

1. Biostatistics: A foundation for Analysis in the Health sciences, Wayne W. Daneil, 10th edition, 2013, John Wiley & Sons.
2. Biostatistics, P. N. Arora, P. K. Malhan, 2nd edition, 2013, Himalaya Publishing House.

E books and online course materials:

1. https://www.coursera.org/learn/basic-statistics
2. https://www.coursera.org/learn/probability-intro
3. https://www.classcentral.com/course/udacity-intro-to-statistics-361
4. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook

Online Courses and Video Lectures:

1. http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics- spring-2014/
2. http://nptel.ac.in/courses/*111105041/1* NPTEL >> Mathematics >> Probability and Statistics
3. https:// www.khanacademy.org/Math
4. https:// www.class-central.com/subject/math (MOOCS)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question in Units 2, 3, 4 and two questions from Unit 1 and Unit 5.

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SYLLABUS (2019 - 2020)

FOURTH SEMESTER B.E COURSE - (MECHANICAL ENGINEERING)

Course Title	Higher Engineering Mathematics	Course Code	19MA4BSHEM
Credits	03	L – T – P	3 -0- 0
Contact hours	36 hours		

Prerequisites: Complex numbers, multivariate calculus and basic concepts of Statistics and Probability.

Course Objectives: To prepare students with adequate knowledge in Probability and Statistics, Complex Analysis and develop computational skills using efficient numerical methods for problems in science and engineering.

UNIT-1

STATISTICS AND PROBABILITY [8 hours]

Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = ab^x$. Correlation and regression.

Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution-normal distribution.

UNIT-2

JOINT PROBABILITY AND MARKOV CHAIN [7 hours]

Joint Probability Distributions:

Discrete random variable, Mathematical expectation, Covariance and Correlation.

Markov Chain:

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chains.

UNIT-3

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS [7 hours]

Finite-Difference formulas to partial derivatives.

Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

UNIT-4

COMPLEX ANALYSIS – 1 [7 hours]

Functions of a complex variable, limits, continuity and differentiability of a complex valued function, Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method.

Conformal mapping. Transformation: $w = z^2$ and $w = z + \frac{a^2}{z}\left(z \neq 0\right)$. Bilinear transformations.

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UNIT-5

COMPLEX ANALYSIS - 2 **[7 hours]**

Complex integration: Line integral, Cauchy's theorem, Cauchy's integral formula.
Complex series: Taylor's, Maclaurin's and Laurent's series (without proof)-examples.
Zeros, Poles and Residues: Cauchy's r esidue theorem (without proof)-examples.

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOMES (CO)	PO
19MA4BSHEM	CO 1	Demonstrate an understanding of concepts of statistical analysis and probability distributions.	1
	CO 2	Apply Numerical techniques to solve partial differential equations arising in engineering.	
	CO 3	Demonstrate an understanding of analytic functions and their application to evaluate integrals.	

Text Books:

1. Numerical Methods for Engineering, R. P. Kanale and S. C. Chapra, 6th edition, McGraw Hill, Publishers.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

Reference Books:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2013, Khanna Publishers.

E_books and online course materials:

1. https://www.coursera.org/learn/basic-statistics
2. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook
3. https://ocw.mit.edu/courses/mathematics/18-112-functions-of-a-complex-variable-fall-2008/lecture-notes/
4. https://www.math.ubc.ca/~peirce/M257_316_2012_Lecture_8.pdf

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/111105090/ (Probability & statistics-Joint distribution, testing of hypothesis)
2. https://nptel.ac.in/courses/111103070/ (Complex Analysis - Analytic functions, Mobius transformation & Residue theorem)
3. https://nptel.ac.in/courses/111107056/ (Complex Analysis - Complex integration, conformal mapping)

Question Paper Pattern:

1. Five full questions to be answered.
2. To set one question in Units 2, 3, 5 and two questions each in unit 1 and unit 4.

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SYLLABUS (2019 - 2020)

FOURTH SEMESTER B.E COURSE

(Common to All Branches)

Course Title	**Additional Mathematics-II**	**Course Code**	**19MA4IMMAT**
Credits	**00**	**L – T – P**	**3 – 1 – 0**
Contact hours	**48 hours (36L+12T)**	**IV semester Lateral Entry students**	

Prerequisites: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

Course Objectives: To provide students with a solid foundation in mathematical fundamentals such as Laplace Transforms, Solution of ordinary differential equations using Laplace Transforms, vector integration, computation of area and volume using double and triple integrals respectively.

UNIT 1

LAPLACE TRANSFORMS **[9 Hours]**

Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting, unit step function and dirac-delta function. **(7L+2T)**

UNIT 2

INVERSE LAPLACE TRANSFORMS **[10 Hours]**

Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE-Initial and Boundary value Problems. **(7L+3T)**

UNIT 3

DOUBLE INTEGRALS **[11 Hours]**

Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area. **(8L+3T)**

UNIT 4

TRIPLE INTEGRALS AND IMPROPER INTEGRALS **[9 Hours]**

Evaluation of triple integral. Application: Volume. Beta and Gamma functions-definition, relation between Beta and Gamma functions, properties and problems.

(7L+2T)

UNIT 5

VECTOR INTEGRATION **[9 Hours]**

Line integral, Green's theorem, Stokes' theorem and Gauss divergence theorem.

(7L+2T)

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On completion of the course, students will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
19MA4IMMAT	CO 1	Use Laplace transforms to solve differential equations.	1
	CO 2	Apply multiple integrals of plane figures to compute areas and volume.	
	CO 3	Use Gamma and Beta functions to evaluate integrals.	
	CO 4	Ability to understand the use of integral calculus in scalar and vector fields.	

Text Book:

1. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

Reference Book:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd

E books and online course materials

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL- xB8dEC&redir_esc=y.
2. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3. http://ocw.mit.edu/courses/mathematics/ (online course material)

Online Courses:

1. https:// www.khanacademy.org/Math
2. https:// www.class-central.com/subject/math (MOOCS)
3. E-learning: www.vtu.ac.in

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SYLLABUS (2020 - 2021)

SIXTH SEMESTER – INSTITUTIONAL ELECTIVE

Course Title	**NUMERICAL METHODS FOR ENGINEERS**	**Course Code**	**20MA6IENME**
Credits	**03**	**L – T – P**	**3 – 0 – 0**
Contact hours	**39 hours**		

Prerequisites: Matrix theory, Differential and Integral Calculus, Differential Equations.

Course Objectives: The purpose of the course is to encourage the students to apply numerical techniques. To enhance computational skills for solving mathematical equations. To train the students to solve the complex engineering problems in their respective domain.

UNIT-1

SYSTEM OF EQUATIONS, EIGEN VALUES AND EIGEN VECTORS: [07 hours]

Fixed point iteration method, Thomas algorithm for tri-diagonal systems, Newton method for solving nonlinear systems.

Rayleigh Power method, Jacobi Method, Given Method.

UNIT-2

INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION: [08 hours]

Linear interpolation, Piecewise polynomial interpolation: Cubic spline interpolation.

Stirling's formula and Bessel's formula. Richardson extrapolation.

Boole and Romberg integrations. Evaluation of Double Integrals using Numerical Methods – Trapezoidal and Simpson Rules.

UNIT-3

INITIAL VALUE PROBLEMS: [08 hours]

4^{th} order Predictor–Corrector methods: Milne and Adam-Bashforth methods. Finite difference methods. Solving system of ODEs using classical, explicit Runge-Kutta 2^{nd} and 4^{th} order methods.

UNIT-4

BOUNDARY VALUE PROBLEMS AND INTEGRAL EQUATIONS: [08 hours]

Introduction to boundary value problem (BVP): Solving BVP using Shooting method, Finite difference method, cubic spline method.

Solution of Fredholm and Volterra integral equations of first kind using finite difference method.

UNIT-5

PARTIAL DIFFERENTIAL EQUATIONS: [08 hours]

Solution of Elliptic PDEs: Laplace and Poisson equations, Finite difference method for 2D elliptic problems, Explicit and implicit finite difference methods for 1D parabolic and hyperbolic problems, ADI method for 2D parabolic problems.

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On completion of the course, student will have the ability to:

Course Code	CO #	COURSE OUTCOME (CO)	PO
20MA6IENME	CO 1	Apply numerical techniques to solve system of equations, eigen value problems, differentiation and integration	1, 5
	CO 2	Interpret the solutions of ordinary differential equations and integral equations	1, 5
	CO 3	Analyze the numerical solutions of partial differential equations	1, 5

Text Books

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, 6th edition, New Age International Publishers, 2007.
2. S. S. Sastry, Introductory methods of numerical analysis, 5th Edition, PHI Publishers, 2012.

Reference Books

1. Steven V. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientists, 3rd Edition, McGraw-Hill Edition, 2011.
2. Richard L. Burden, Douglas J. Faires, A. M. Burden, Numerical Analysis, 9th Edition, Cengage Publishers, 2010.
3. M. D. Raisingania, Integral Equations and Boundary Value Problems, 10th Edition, S. Chand Publishers, 2020.

Online resources

1. https://www.classcentral.com/course/swayam-numerical-methods-for-engineers-14213
2. https://onlinecourses.nptel.ac.in/noc19_ge30/preview
3. https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/

Question Paper Pattern

1. Five full questions to be answered.
2. Each unit consists of one full question.
3. Each full question consists of two, three or four sub divisions.
4. Internal choice to be given in Units 3 and 4.

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SYLLABUS (2021 - 2022)

SEVENTH SEMESTER – INSTITUTIONAL ELECTIVE

Course Title	NUMBER THEORY	Course Code	21MA7IENMT
Credits	03	L – T – P	3 – 0 – 0
Contact hours	39 hours		

Course Objectives:

The course is a graduate level introduction to Number Theory in which fundamentals of the subject will be covered. It contributes to many practical problems such as Coding Theory and Cryptography in modern information technology.

UNIT-1

CONGRUENCES: [09 hours]

Introduction, Congruences and Equivalence Relations, Linear Congruences, Linear Diophantine Equations and the Chinese Remainder Theorem, Modular Arithmetic: Fermat's Theorem, Wilson's Theorem and Fermat Numbers. Polynomial congruences, Pythagorean equations.

UNIT-2

ARITHMETIC FUNCTIONS: [07 hours]

Introduction, Sigma Function, Tau Function, Dirichlet Product, Dirichlet Inverse, Moebius Function, Euler's Function, Euler's Theorem.

UNIT-3

PRIMITIVE ROOTS AND INDICES: [07 hours]

The order of a positive integer, primality tests, primitive roots for primes, the algebra of indices.

UNIT-4

QUADRATIC CONGRUENCE AND CONTINUED FRACTION: [09 hours]

Legendre symbol, quadratic reciprocity, the Jacobi symbol, finite continued fractions, infinite continued fractions.

UNIT-5

NON LINEAR DIOPHANTINE EQUATIONS: [07 hours]

Pythagorean triangles, Fermat's last theorem, Sum of Squares, Pell's equation, Mordell's equation.

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On completion of the course, student will have the ability to:

CO No	Course Outcomes	PO
1	Apply the concept of congruence to compute system of equations (algebraic equations) and non-linear Diophantine equation	**1**
2	Demonstrate an understanding towards the nature of different functions, primitive roots and indices	**1**
3	Apply concept of quadratic congruence to evaluate quadratic residues and understand continued fractions	**1**

Text Books

1. Thomas Koshy, Elementary number theory with Applications, 2nd Edition, Elsevier, 2009.
2. Neville Robbins, Beginning Number Theory, 2nd Edition, Jones and Barlett, 2006.
3. Ivan Niven, Herbert S. Zukerman and Hugh L. Montgomery, Introduction to theory of Numbers, 7th edition, Wiley, 2000.

Reference Books

1. David M. Burton, Elementary Number Theory, 6th Edition, Tata McGraw Hill Publ., 2006.
2. Gareth A. Jones and Josephine Mary Jones, Elementary Number Theory, Springer, 1998.

Question Paper Pattern

- Five full question to be answered.
- Each unit consists of one full question.
- Each full question consists of two, three or four subdivisions.
- Internal choice in Unit 1 and Unit 4.

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SYLLABUS (2021 - 2022)

SEVENTH SEMESTER – INSTITUTIONAL ELECTIVE

Course Name	**Computational Graph Theory**	**Course Code**	**21MA7IECGT**
Credits	**03**	**L – T - P**	**3 - 0 - 0**
Contact hours	**39 hours**		

Course Objectives: The objective of the course is to introduce the concepts in graph Theory, with a sense of algorithms and some modern applications. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

UNIT-1

GRAPHS AND DIGRAPHS **[8 hours]**

Fundamentals of graphs and digraphs, modelling using graphs and digraphs, graph search – BFS, DFS. The shortest path algorithms: Dijkstra algorithm, Bellman algorithm. Minimum weight spanning tree: Kruskal's algorithm and Prim's algorithms. Applications: Job sequencing problems, designing an efficient computer drum, making a road system one-way.

UNIT-2

EULERIAN AND HAMILTONIAN GRAPHS **[7 hours]**

Transportation Problems: Eulerian graphs, Fleury's algorithm, Chinese Postman Problem, Hamiltonian cycles, Travelling Salesman Problem, applications.

UNIT-3

CONNECTIVITY **[8 hours]**

Cut vertex and cut edges, vertex and edge connectivity, separable graphs, block graphs, k-connected graphs, maximum flow Problem, Ford-Fulkerson algorithm, Min Cut - Max Flow theorem, Maximum Flow of Minimum Cost, feasible flows. The connector problem, construction of reliable communication networks.

UNIT-4

COVERING AND MATCHING **[8 hours]**

Vertex and edge covering, vertex and edge independence, matchings, perfect matchings, maximum matching, Hall's theorem, augmenting path, Edmond's algorithm, König's theorem, König's Min-Max theorem, Gale-Shapley Algorithm, Minimum path cover**,** Friend's strangers problem.

UNIT-5

COLORABILITY **[8 hours]**

Vertex colouring, Chromatic Number, Bi-chromatic, Edge coloring and its applications to timetabling and sport scheduling, Vizing's theorem, Sequential coloring algorithm, map coloring, Four Color problem, chromatic polynomial.

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Text Books

1. Narsing Deo, Graph Theory, PHI, 2014.
2. Geir Agnarsson & Raymond Greenlaw Pearson, Graph Theory, modelling, applications and algorithms, Prentice Hall, 2007.

Reference Books

1. Frank Harary, Graph Theory, Addison Wesley, Reading, Massachussets, 1969.
2. Jonathan L. Gross, Jay Yellen, Graph Theory and its Applications, 2nd Edition, CRC Press LLC, Florida, 2000.
3. Gary Chartrand and Ping Zhang, Introduction to Graph Theory, McGraw Hill, 2005.

At the end of the course the students will be able to

CO	Course Outcomes	PO's
CO-1	Demonstrate an understanding of the fundamental concepts of graph theory, digraphs, trees, finding Paths and cycles, weighted graphs matching and graph coloring.	**1,2**
CO-2	Apply appropriate graph algorithms to solve problems involving transportation, connection, social networking and scheduling.	**1,2**
CO-3	Analyse the algorithms to find the shortest path, maximum flow of minimum cost, maximum matching and minimum path cover.	**2**
CO-4	Use of MATLAB to find the shortest path, minimum weighted spanning tree, maximum flow.	**5**

Question Paper Pattern

- Each unit consists of one full question.
- Five full question to be answered.
- Internal choice in Unit 3 and Unit 5.

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SYLLABUS(2021 - 2022)

EIGHTH SEMESTER – INSTITUTIONAL ELECTIVE - (Except CSE/ISE Branch)

Course Title	**Linear Algebra**	**Course Code**	**21MA8IELIA**
Credits	**03**	**L – T – P**	**3 – 0 – 0**
Contact hours	**39 hours**		

Prerequisites: Vector Algebra, Matrix theory, Calculus, Geometry, Group Theory.

Course Objectives: To provide the students with a foundation of concepts in linear algebra that is essential to engineers of computer and information science.

UNIT-1

VECTOR SPACES **[8 hours]**

Vector spaces, Subspaces, Linear Combinations, Linear Spans, row space and column space of a Matrix, Linear Dependence and Independence, Basis and Dimension, Coordinates.

UNIT-2

LINEAR TRANSFORMATIONS **[8 hours]**

Introduction, Linear Mappings, Geometric linear transformation of $\mathbb{R}^2$, Kernel and Image of a linear transformations, Matrix representation of linear transformations, Rank-Nullity Theorem(No proof), Singular and Nonsingular linear transformations, Invertible linear transformations.

UNIT-3

EIGENVALUES AND EIGENVECTORS **[8 hours]**

Introduction, polynomials of matrices, characteristic polynomial, Cayley-Hamilton theorem, eigenvalues and eigenvectors, eigen spaces of a linear transformation, diagonalization, minimal polynomial, characteristic and minimal polynomials of block matrices, Jordan canonical form.

UNIT-4

INNER PRODUCT SPACES **[8 hours]**

Inner product, inner product spaces, length and orthogonality, orthogonal sets and Bases, projections, Gram-Schmidt process, QR-factorization, least squares problem and least square error.

UNIT-5

SYMMETRIC MATRICES AND QUADRATIC FORMS **[7 hours]**

Diagonalization of real symmetric matrices, Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, Singular value decomposition.

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On completion of the course, student will have the ability to:

Course Code	CO #	Course Outcome (CO)	PO
21MA8IELIA	CO 1	Apply the concepts of vectors spaces	1
	CO 2	Relate the concepts of Eigenvalues, Eigenvectors & functions to linear algebra	
	CO 3	Apply the concepts of inner products	

Text Books

1. David C. lay, Steven R. lay and Judi J Mc. Donald, Linear Algebra and its applications, 5th edition, Pearson Education, 2015.
2. Seymour Lipschutz, Schaum's outline series-Theory and problems of linear algebra, 5th edition, McGraw-Hill Education, 2012.

Reference Books

1. Gilbert Strang, Linear Algebra and its applications, 4th edition, Brooks Cole, 2005.
2. Richard Bronson and Gabriel B. Costa, Linear Algebra: An Introduction, 2nd edition, Academic press, 2007.

E books and online course materials

1. https://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/index.htm
2. https://www.math.ucdavis.edu/~linear/linear.pdf

Online Courses and Video Lectures

1. https://www.coursera.org/learn/linear-algebra-machine-learning
2. https://nptel.ac.in/syllabus/111106051/

Question Paper Pattern

1. Five full questions to be answered
2. Each unit consists of one full question.
3. Each full question consists of two, three or four subdivisions.
4. Internal Choice in Units 3 and 4.

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