B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

DEPARTMENT OF MATHEMATICS

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 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]**

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. Construction of reliable communication networks-The minimum connector problem, enumeration of chemical molecules and electrical 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, maximal independent sets, 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. König's theorem, Applications: Scheduling examinations, Frequency assignments, Index registers.

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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)

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)

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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