Syllabus

Mathematics (Regular)

Version 2

submitted to

Gauhati University

under the

Choice Based Credit System

By

Department of Mathematics

Gauhati University

"This is approved in the Academic Council held on 08/11/2019"

Credits allocation for the Regular courses:

Course Theory + Practical	*Credits Theory + Tutorial	*Credits Theory + Practical
I. Core Course (6 Credits)		
(12 Papers)	12×4= 48	12×5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*		
(12 Practical/Tutorials*)	12×2=24	12×1=12
04 Courses from each of the 03 disciplines of choice		
II. Elective Course (6 Credits)		
(6 Papers)	6×4=24	6×5=30
Two papers from each discipline of choice including paper of interdisciplinary nature		
Elective Course Practical / Tutorial*	6 × 2=12	6×1=6
Two papers from each discipline of choice including paper of interdisciplinary nature		
Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory Courses (AECC) (2 Papers of 4 credit each)**	2 × 4=8	2 × 4=8
Environmental Science		
English Communication		
2. **Skill Enhancement Courses (SEC) (4 Papers of 4 credit each)**	4 × 4=16	4× 4=16
Total credit	**132**	**132**

* wherever there is a practical there will be no tutorial and vice-versa

CBCS Course Structure for Under -Graduate BA, BSc, BCom Programme (Regular)
SEMESTER WISE PLACEMENT OF THE COURSES

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC)(2)	SkillEnhancement Course (SEC)(4)	Discipline Specific Elective (DSE)(6)
I	**MAT-RC-1016: Calculus**	**ENG-AE-1014**		
II	**MAT-RC-2016: Algebra**	**ENV-AE-2014**		
III	**MAT-RC-3016: Differential Equations**		**SEC-1 MAT-SE-3014:** Computer Algebra Systems and Related Software	
IV	**MAT-RC-4016: Real Analysis**		**SEC-2 MAT-SE-4014:** R Programming	
V			**SEC-3 MAT-SE-5014:** Combinatorics and Graph Theory	**DSE-1 MAT-RE-5016:** Number Theory **MAT-RE-5026:** Discrete Mathematics
VI			**SEC-4 MAT-SE-6014:** LaTeX and HTML	**DSE-2 MAT-RE-6016:** Numerical Analysis **MAT-RE-6026:** Programming in C

Legends:

RC: Regular Core   RE: Regular Discipline Specific Elective
SE: Skill Enhancement Course

Core papers (Mathematics):

1. MAT-RC-1016: Calculus
2. MAT-RC-2016: Algebra
3. MAT-RC-3016: Differential Equations
4. MAT-RC-4016: Real Analysis

Skill Enhancement Course (SEC) papers

SEC-1
MAT-SE-3014:Computer Algebra Systems and Related Software

SEC-2
MAT-SE-4014: R Programming

SEC-3
MAT-SE-5014:Combinatorics and Graph Theory

SEC-4
MAT-SE-6014: LaTeX and HTML

Discipline Specific Elective (DSE) papers

DSE-1 (Choose one)
MAT-RE-5016: Number Theory
MAT-RE-5026**:** Discrete Mathematics

DSE-2 (Choose one)
MAT-RE-6016: Numerical Analysis
MAT-RE-6026:Programming in C

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Details syllabus for B.Sc. / B. A. / B. Com
(Regular Course)
SEMESTER-I
MAT-RC-1016:Calculus
Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits**:** 6,*Each unit carry equal credit*

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Course Objectives: The primary objective of this course is to introduce the graphs of functions and basic tools of calculus and geometric properties which are helpful in understanding their applications in real world problems.

Course Learning Outcomes: This course will enable the students to:
i) Learn differentiability, limit and continuity tests for functions.
ii) Learn different theorems alongwith their geometric properties.
iii) Learn partial differentiation of functions

Unit 1: Graphs of simple concrete functions such as polynomial, Trigonometric, Inverse trigonometric, Exponential and logarithmic functions
[1] Chapter 1 (Sections 1.1 to 1.3), and Chapter 7 (Sections 7.2, 7.3, and 7.6)

Unit 2: Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem.
[2] Chapter 1

Unit 3: Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives.
[2] Chapter 3 (Sections 3.2, 3.3, and 3.6), and Exercise 26, page 184.

Unit 4: Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Taylor's theorem, Taylor's series and Maclaurin's series, Maclaurin's series expansion of functions such as heir use in polynomial approximation and error estimation.
[1] Chapter 4 (Sections 4.2, and 4.3), [2] Chapter 9 (Sections 9.8, and 9.9)

Unit 5: Functions of two or more variables, Graphs and level curves of functions of two variables, Partial differentiation up to second order.
[2] Chapter 13 (Sections 13.1, and 13.3)

Text books:
1. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas' Calculus* (13th ed). Pearson Education, Delhi. Indian Reprint 2017.
2. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi

SEMESTER-II
MAT-RC-2016: Algebra
Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial Credits:6, *Each unit carry equal credit*

Course Objectives: The primary objective of this course is to introduce the basic theory of equations and trigonometric function, matrices and determinant as well as algebra of vector spaces

Course Learning Outcomes: This course will enable the students to:
i) Employ De Moivre's theorem to solve problems.
ii) Learn about matrices, determinant and application in solving system of euations
iii) Learn about vector space algebra and their application

Unit 1: Theory of Equations and Expansions of Trigonometric Functions:
Fundamental Theorem of Algebra, Relation between roots and coefficients of nth degree equation, Remainder and Factor Theorem, Solutions of cubic and biquadratic equations, when some conditions on roots of the equation are given, Symmetric functions of the roots for cubicand biquadratic; De Moivre's theorem (both integral and rational index), Solutions of equations using trigonometry and De Moivre's theorem, Expansion for in terms of powers of in terms of cosine and sine of multiples of x.
[2] Chapter 3, 4 [3] Chapter 7 (Sections 7.6 and 7.7)

Unit 2: Matrices:
Types of matrices, Rank of a matrix, Invariance of rank under elementarytransformations, Reduction to normal form, Solutions of linear homogeneous and nonhomogeneous equations with number of equations and unknowns up to four; Cayley-Hamilton theorem, Characteristic roots and vectors.

[4] Chapter 3 (Sections 3.2, 3.5, and 3.7,Section 3.9)Chapter 2 (Sections 2.1 to 2.5)Chapter 7 (Section 7.1, and Example 7.2.2)

Unit 3: Groups, Rings and Vector Spaces:

Integers modulo n, Permutations, Groups, Subgroups, Lagrange's theorem, Euler's theorem, Symmetry Groups of a segment of a line, and regular n-gons for n = 3, 4, 5, and 6; Rings and subrings in the context of C[0,1] and Definition and examples of a vector space, Subspace and its properties, Linear independence, Basis and dimension of a vector space.

[1] Chapter 1 (Section 1.4), and Chapter 2 (Section 2.3)Chapter 3 (Sections 3.1, and 3.2)(Sections 3.2, 3.3, and 3.6) and Chapter 5 (Section 5.1)
[4] Chapter 4 (Sections 4.1, 4.3, and 4.4)

Text Books:
1. Beachy, John A., & Blair, William D. (2006). *Abstract Algebra* (3rd ed.). Waveland Press, Inc.
2. Burnside, William Snow (1979). *The Theory of Equations*, Vol. 1 (11th ed.) S. Chand & Co. Delhi. Fourth Indian Reprint.
3. Gilbert, William J., & Vanstone, Scott A. (1993). *Classical Algebra* (3rd ed.). Waterloo Mathematics Foundation, Canada.
4. Meyer, Carl D. (2000). *Matrix Analysis and Applied Linear Algebra*. Society for Industrial and Applied Mathematics (Siam).

Reference Books:
1. Dickson, Leonard Eugene (2009). *First Course in The Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
2. Gilbert, William J. (2004). *Modern Algebra with Applications* (2nd ed.). John Wiley & Sons.

SEMESTER-III
MAT-RC-3016: Differential Equations
Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits: 6,*Each unit carry equal credit*

Course Objectives: The main objective of this course is to introduce the students to the exciting world of differential equations and their solutions methods.

 Course Learning Outcomes: The course will enable the students to:
i) Learn basics of differential equations and mathods for solving.

Unit 1: First Order Ordinary Differential Equations
First order exact differential equations, Integrating factors, Rules to find an integrating factor
[1] Chapter 1 (Section 1.1,1.2 1.4)
[2] Chapter 1 (Sections 1.1, and 1.2)Chapter 2 (Sections 2.1, and 2.2)

Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories; Basictheory of higher order linear differential equations, Wronskian, and its properties; Solving differential equation by reducing its order.
[2] Chapter 2 (Sections 2.3, and 2.4), Chapter 3 (Section 3.1), and Chapter 4 (Section 4.1)

Unit 2: Second Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, Themethod of variation of parameters, The Cauchy-Euler equation; Simultaneous differentialequations.
[1] Chapter 2 (Section 2.2)
[2] Chapter 4 (Sections 4.2, 4.3, 4.4, 4.5,4.6) Chapter 7 (Sections 7.1, 7.3)

Text Books:
1. Kreyszig, Erwin (2011). *Advanced Engineering Mathematics* (10th ed.). John Wiley &Sons, Inc. Wiley India Edition 2015.
2. Ross, Shepley L. (1984). *Differential Equations* (3rd ed.). John Wiley & Sons, Inc

SKILL ENHANCEMENT COURSE
SEC-1
MAT-SE-3014: Computer Algebra Systems and Related Software

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practical, Credits 4(2+2)
Each unit carry equal credit.

Course Objectives: This course aims at familiarizing students with the usage of mathematical softwares (/Mathematica/MATLAB/Maxima/Maple) and the statistical software **R**. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in **R**. Graphical representation of data shall also be explored.

Course Learning Outcomes: This course will enable the students to:
i) Use of softwares; Mathematica/MATLAB/Maxima/Maple etc. as a calculator, for plotting functions and animations
ii) Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.
iii) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**
iv) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data.
v) Analyze, test, and interpret technical arguments on the basis of geometry

Unit 1: Introduction to CAS and Applications:
Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.
[1] Chapter 12 (Sections 12.1 to 12.5)
[2] Chapter 1, and Chapter 3 (Sections 3.1 to 3.6, and 3.8) Chapter 6 (Sections 6.2, and 6.3)

Unit 2: Working with Matrices:
Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.
[2] Chapter 7 (Sections 7.1 to 7.8)

Practical:
List of the practical to be done using Matlab / Mathematica / Maple / Scilab / Maxima etc.
Six practicals should be done by each student. The teacher can assign practical from the exercises from [1].

Text Book:
1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

Reference Book:
1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.

SEMESTER-IV
MAT-RC-4016: Real Analysis
Total Marks: 100(Theory: 80 Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial, Credits:6,*Each unit carry equal credit*

Course Objectives: The course will develop a deep and rigorous understanding of real line R and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers.

Course Learning Outcomes: This course will enable the students to:
i) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit, algebra of limit and uniform continuity of functions.
ii) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Unit 1: Order completeness of Real numbers, Open and closed sets, Limit of functions, Sequential criterion for limits, Algebra of limits, Properties of continuous functions, Uniform continuity.
[1] Chapter 2 (Sections 2.1, and 2.2, Sections 2.3, and 2.4)Chapter 11 (Section 11.1, Definition and Examples only)

Unit 2: Sequences, Convergent and Cauchy sequences, Subsequences, Limit superior and limit inferiorof a bounded sequence, Monotonically increasing and decreasing sequences, Infinite series andtheir convergences, Positive term series, Comparison tests, Cauchy's nth root test, D'Alembert's ratio test, Raabe's test, Alternating series, Leibnitz test, Absolute and conditionalconvergence.
[1] Chapter 3, (Sections 3.1, 3.2,3.3,3.4,3.5,3.7), Chapter 9 [Section 9.1(excluding grouping of series)]Sections 9.2 (Statements of tests only), and 9.3 (9.3.1, 9.3.2)Chapter 4 (Sections 4.1 to 4.3).Chapter 5 (Sections 5.1, 5.3, 5.4 excluding continuous extension and approximation)

Text Book:
1. Bartle, Robert G., &Sherbert, Donald R. (2015). *Introduction to Real Analysis* (4th ed.) Wiley India Edition.
Reference Book:
1. Ross, Kenneth A. (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint
2. Bilodeau, Gerald G., Thie, Paul R., &Keough, G. E. (2010). *An Introduction to Analysis* (2nd ed.). Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

SKILL ENHANCEMENT COURSE
SEC-2

MAT-SE-4014: R Programming

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practical, Credits 4(2+2)
Each unit carry equal credit.

Course Objectives: The purpose of this course is to help using **R**, a powerful free software program for doing statistical computing and graphics. It can be used for exploring and plotting data, as well as performing statistical tests.

Course Learning Outcomes: This course will enable the students to:
i) Become familiar with **R** syntax and to use **R** as a calculator.
ii) Understand the concepts of objects, vectors and data types.
iii) Know about summary commands and summary table in **R**.
iv) Visualize distribution of data in **R** and learn about normality test.
v) Plot various graphs and charts using **R**.

Unit 1: **Getting Started with R - The Statistical Programming Language**
Introducing **R**, using **R** as a calculator; Explore data and relationships in **R**; Reading and getting data into **R**: combine and scan commands, viewing named objects and removing objects from **R**, Types and structures of data items with their properties, Working with history commands, Saving work in **R**; Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions.
[1] Chapter 14 (Sections 14.1 to 14.4)
[2] Chapter 2, Chapter 3

Unit 2: **Descriptive Statistics and Tabulation**
Summary commands**:** Summary statistics for vectors, Data frames, Matrices and lists; Summary tables.
[2] Chapter 4

Unit 3: **Distribution of Data**
Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro-Wilk test for normality, The Kolmogorov-Smirnov test.
[2] Chapter 5

Unit 4: Graphical Analysis with R
Plotting in **R:** Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.
[1] Chapter 14 (Section 14.7)
[2] Chapter 7

Practical to be done in the Computer Lab using Statistical Software R:
[1] Chapter 14 (Exercises 1 to 3)
[2] Relevant exercises of Chapters 2 to 5, and 7

Note: The practical may be done on the database to be downloaded from https://data.gov.in/

Text books:
1. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.
2. Gardener, M. (2012). *Beginning* **R:** *The Statistical Programming Language*, Wiley Publications.

SKILL ENHANCEMENT COURSE

SEC-3
MAT-SE-5014: Combinatorics and Graph Theory

Total marks: 100 (Theory 80, Internal Assessment 20)
Per week: 4 Lectures, Credits 4
Each unit carry equal credit

Course Objectives: This course aims to provide the basic tools of conuting principles, pigeonhole principle. Also introduce the basic concepts of graphs, Eulerian and Hamiltonian graphs, and applications to dominoes, Diagram tracing puzzles, Knight's tour problem and Gray codes.

Course Learning Outcomes: This course will enable the students to:
i) Learn about the counting principles, permutations and combinations, Pigeonhole principle
ii) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight's tour problem.

Unit 1: Elementary combinatorics, Rules of sum and product, two models of counting, sample and distribution model of counting. Examples and solution. Integer solution of an equilateral problem.
[1] Chapter 3

Unit 2: Graphs, Diagraphs, Networks and subgraphs, Vertex degree, Paths and cycles, Regular and bipartite graphs, Four cube problem, Social networks, Exploring and traveling, Eulerian and Hamiltonian graphs, Applications to dominoes, Diagram tracing puzzles, Knight's tour problem, Gray codes.
[2] Chapter 1 (Section 1.1) and Chapter 2

Text Books:
1. C.L. Liu and D. Mohapatra Elements of discrete mathematics, Mc Graw Hill, Computer Science Series. 2017
2. Aldous, Joan M., & Wilson, Robin J. (2007). *Graphs and Applications*: *An Introductory Approach*. Springer. Indian Reprint.

Reference Books:
1. Michael Towusend, Discrete Mathematics; Applied Combinatorics and Graph Theory, Benjamin-Cummings Pub Co (March 1, 1987)
2. K.R. Parthasarathi, Basic Graph Theory, Tata McGraw-Hill, 1994.

DISCIPLINE SPECIFIC ELECTIVE

MAT-RE-5016: Number Theory

Total Marks: 100 (Theory 80, Internal assessment 20)
Per week: 5 lectures 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes: This course will enable the students to:

i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.

Unit 1: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.
[1] Chapter 2 (Section 2.5), [2] Chapter 2 (Section 2.2, 2.3), Chapter 4 (Sections 4.2, 4.4) Chapter 5:Section 5.2

Unit 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phifunction, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.
[1] Chapter 6 (Sections 6.1 to 6.2, 7.2M 7.3, and 7.4)

Text Books:
1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.
2. Jones, G. A., & Jones, J. Mary. (2005). *Elementary Number Theo*ry. Undergraduate Mathematics Series (SUMS). First Indian Print.

Reference Book:
1. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

MAT-RE-5026: Discrete Mathematics

Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week 5 Lectures, 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: The course aims at introducing the concepts of ordered sets, lattices, sublattices and homomorphisms between lattices. It also includes introduction to modular and distributive lattices along with complemented lattices and Boolean algebra. Then some important applications of Boolean algebra are discussed in switching circuits.

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of ordered sets and maps between ordered sets.
ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
iii) Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.

Unit 1: Ordered Sets
Definitions, Examples and basic properties of ordered sets, Order isomorphism, Hasse diagrams, Dual of an ordered set, Duality principle, Maximal and minimal elements, Building new ordered sets, Maps between ordered sets.
[1] Chapter 1 (Sections 1.1 to 1.5 and 1.14 to 1.26, and 1.34 to 1.36)
[3] Chapter 1 [Section 1 (1.1 to 1.3)]

Unit 2: Lattices
Lattices as ordered sets, Lattices as algebraic structures, Sublattices, Products and homomorphisms; Definitions, Examples and properties of modular and distributive lattices, The M3 – N5 Theorem with applications, Complemented lattice, Relatively complemented lattice, Sectionally complemented lattice. homomorphisms.

[1] Chapter 2 (Sections 2.1 to 2.19)Chapter 4 (Sections 4.1 to 4.9)(Sections 4.10, and 4.11)
[3] Chapter 1 [Section 1 (1.5 to 1.20)]Chapter 1 [Section 2 (2.1 to 2.6) Chapter 1 [Section 2 (2.7 to 2.14)]

Unit 3: Boolean Algebras and Switching Circuits
Boolean Algebras, De Morgan's laws, Boolean homomorphism, Representation theorem; Boolean polynomials, Boolean polynomial functions, Disjunctive normal form and conjunctive normal form, Minimal forms of Boolean polynomial, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits and applications of switching circuits.
[3] Chapter 1 (Sections 3, and 4) Chapter 1 (Section 6)Chapter 2 (Sections 7, and 8).

Text Books:
1. Davey, B. A., & Priestley, H. A. (2002). *Introduction to Lattices and Order* (2nd ed.). Cambridge University press, Cambridge
2. Goodaire, Edgar G., & Parmenter, Michael M. (2011). *Discrete Mathematics with Graph Theory* (3rd ed.). Pearson Education (Singapore) Pvt. Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Gunter. (2004). *Applied Abstract Algebra* (2nd ed.), Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint.

SEMESTER-VI

SKILL ENHANCEMENT COURSE

SEC-4
MAT-SE-6014: LaTeX and HTML(P)

Total marks: 100 (Theory 60, Internal assessment 20, Practical 20)
Per week: 2 Lectures, 2 Practicals, Credits 4(2+2)
Each unit carry equal credit

Course Objectives: The purpose of this course is to acquaint students with the latest typesetting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages

Course Learning Outcomes: After studying this course the student will be able to:
i) Create and typeset a LaTeX document.
ii) Typeset a mathematical document using LaTex.
iii) Learn about pictures and graphics in LaTex.
iv) Create beamer presentations.
v) Create web page using HTML.

Unit 1: Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; Beamer presentation
[1] Chapters 9,10, 11.

Unit 2: HTML, creating simple web pages, images and links, design of web pages.
[1] Chapter 9-11, 15

Practical: Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

Text Book:
1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.
   Reference Book:
1. L. Lamport, LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994

MAT-RE-6016: Numerical Analysis

Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week 5 Lecture, 1 Tutorial, Credits 6
Each unit carry equal credit

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and Quadratic equations.

Course Learning Outcomes: The course will enable the students to:
i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
ii) Know about iterative and non-iterative methods to solve system of linear equations
iii) Know interpolation techniques to compute the values for a tabulated function at points not in the table.
iv) Integrate a definite integral that cannot be done analytically
v) Find numerical differentiation of functional values
vi) Solve differential equations that cannot be solved by analytical methods

Unit 1: Gaussian elimination method (with row pivoting), Gauss-Jordan method; Iterative methods**:** Jacobi method, Gauss-Seidel method; Interpolation**:** Lagrange form, Newton form, Finite difference operators, Gregory-Newton forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).
[2] Chapter 3 (Sections 3.1, and 3.2), Chapter 6 (Sections 6.1, and 6.2) Chapter 8 (Section 8.1, Section 8.3 (8.3.1, and 8.3.2)
[3] Chapter 3 (Sections 3.2, and 3.4) Chapter 4 (Section 4.2)Chapter 4 (Sections 4.3, and 4.4)
[1] Chapter 18 (Sections 18.1 to 18.3)

Unit 2: Numerical differentiation**:** First and second order derivatives; Numerical integration**:** Trapezoid rule, Simpson's rule; Extrapolation methods**:** Richardson extrapolation, Romberg integration; Ordinary differential equation**:** Euler's method, Modified Euler's methods **(**Heun and Mid-point).
[2] Chapter 11 [Sections 11.1 (11.1.1, 11.1.2, 11.1.4), and 11.2 (11.2.1, 11.2.2, 11.2.4)]
[1] Chapter 22 (Sections 22.1, and 22.2, 22.3)

Text Books:
1. Chapra, Steven C. (2018). *Applied Numerical Methods with* MATLAB *for Engineers and* Scientists (4th ed.). McGraw-Hill Education.
2. Fausett, Laurene V. (2009). *Applied Numerical Analysis Using* MATLAB. Pearson. India
3. Jain, M. K., Iyengar, S. R. K., & Jain R. K. (2012). *Numerical Methods for Scientific and Engineering Computation* (6th ed.). New Age International Publishers. Delhi.

MAT-RE-6026: Programming in C

Total Marks: 100 (Theory 60, Internal 20, Practical 20)
Per week: 4 Lectures, 2 Tutorials, Credits 6(4+2)
Each unit carry equal credit

Course Objectives: This course introduces C programming in the idiom and context of mathematics and imparts a starting orientation using available mathematical libraries, and their applications.

Course Learning Outcomes: After completion of this paper, student will be able to:
i) Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving.

ii) Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.

iii) Use of containers and templates in various applications in algebra.

iv) Use mathematical libraries for computational objectives.

v) Represent the outputs of programs visually in terms of well formatted text and plots.

Unit 1: Variables, constants, reserved words, variable declaration, initialization, basic data types, operators and expression (arithmetic, relational, logical, assignment, conditional, increment and decrement), hierarchy of operations for arithmetic operators, size of and comma operator, mixed mode operation and automatic (implicit) conversion, cast (explicit) conversion, library functions, structure of a C program, input/output functions and statements.

Unit 2 : Control Statements : if-else statement (including nested if-else statement), switch statement. Loop control Structures (for and nested for, while and do-while). Break, continue, go to statements, exit function.

Unit 3 : Arrays and subscripted variables : One and Two dimensional array declaration, accessing values in an array, initializing values in an array, sorting of numbers in an array, addition and multiplication of matrices with the help of array.
Functions : function declaration, actual and formal arguments, function prototype, calling a function by value, recursive function.
[1] Chapters 3, 4, 5, 6, 7 and 9

Programmes for practical:
To find roots of a quadratic equation, value of a piecewise defined function (single variable), factorial of a given positive integer, Fibonacci numbers, square root of a number, cube root of a number, sum of different algebraic and trigonometric series, a given number to be prime or not, sum of the digits of any given positive integer, solution of an equation using N-R algorithm, reversing digits of an integer. Sorting of numbers in an array, to find addition, subtraction and multiplication of matrices. To find sin(x), cos(x) with the help of functions.
[1] Chapters 3, 4, 5, 6, 7 and 9

Text Book:
   1. T. Jeyapoovan, A First Course in Programming with C T. Jeyapoovan, Vikash Publishing House Pvt. Ltd.
Reference books:
   1. E. Balaguruswamy-Programming with C, Schaum Series.
   2. Y. Kanetkar, *Let us C*, B.P. Publication.

GENERIC ELECTIVE (GE) COURSES
OFFERED TO B.A./B.Com. Programme
(Students who are not having Mathematics as a discipline Subject can opted for such courses)

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE)(4)	Generic Elective (GE) (2) Credits: 6 each
I					
II					
III					
IV					
V					**GE-1: MAT-RG-5016 General Mathematics-I**
VI					**GE-2: MAT-RG-6016 General Mathematics-II**

SEMESTER-V
MAT-RG-5016: General Mathematics-I

Total Marks: 100(Theory: 80, Internal Assessment: 20)
Per week: 5 Lectures, 1 Tutorial,Credits6
Each unit carry equal credit

Course Objectives: In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems. Encient mathematics are the foundations of present mathematics and so a brief introduction of the same is included. Matrix method is introduced to solve equations.

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.
iv) Know solve simultaneous algebraic equations with matrix theory.

Unit 1: Biographies of Ancient Indian Mathematicians: A brief introduction to the lives and information on the works of the following Mathematicians**:** Aryabhata, Varahamihira, Brahmagupta, Bhaskara I & II, Mahavira, Madhava, and Paramesvara.
[3] Chapters 5, 6, 7, 9, 11 and 13 for brief statements and examples on the works of the above Mathematicians.
[4] Sections 30, 31, 35, 41 to 44, 54 to 56, 59 to 61, 67 and 68 for brief introduction of the Mathematicians.

Unit 2: Number Systems: An overview of number systems, Algebraic and transcedental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and Modular arithmetic, Euclidean algorithm, Prime numbers, The sieve of Eratosthenes, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjectures, Twin primes, Uses of prime numbers, Perfect and amicable numbers, Pythagoreans triplets and its properties, Statement and historic background of Fermat's Last Theorem, Multiplication principle, Permutation and combinations, Latin squares and magic squares.

[2] Chapter 3 (Sections 3.0, 3.1, and 3.4), and Chapter 4 (Section 4.2 up to page 128) Chapter 3 (Section 3.2) Chapter 3 (Section 3.3), and Chapter 9 (Section 9.9, pages 332 to 334).Chapter 5 (Sections 5.1 to 5.4, and 5.6 up to page 212)

Unit 3: Matrices and Determinants: Matrices, Basic concepts and algebraic operations, Types of matrices, Transpose of a matrix, Symmetric and skew-symmetric matrices, Matrix multiplication and its properties, Powers of square matrices, Inverse square matrix and its properties, Determinant and its properties, Expansion by rows and columns, Cofactors, Matrix singularity, Adjoint matrix and calculation of inverse, Cramer's rule.
[1] Chapter 1 (Sections 1.4, and 1.5)Chapter 2 (Section 2.4 up to Example 3, page 138), and Chapter 3 (Sections 3.1 to 3.3)

Text Books:
1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebra* (5th ed.). Academic Press, Elsevier India Private Limited.
2. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
3. Puttaswamy, T.K. (2012). Mathematical Achievements of Pre-modern Indian Mathematicians Elsevier Inc. USA.
4. Srinivasiengar, C. N. (1988). *The History of Ancient Indian Mathematics*. The World Press Private Ltd. Calcutta. Digitized Book (2009).

Reference Book:
1. Divakaran, P. P. (2018). The Mathematics of India: Concepts, Methods, Connections. Springer Singapore. Indian Print by Hindustan Book Agency, New Delhi.

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SEMESTER-VI
MAT-RG-6016: General Mathematics – II

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Total Marks: 100 (Theory 80, Internal Assessment 20)
Per week: 5 Lectures, 1 Tutorial,Credits6
Each unit carry equal credit

Course Objectives: History and biographies of renowned ancient scientists in mathematical science are included to inspire the students and therby develop love mathematics. Basics of graph theory and number theory are included as well. Matrix method is introduced to solve equations and a brief introduction functions are included.

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating problems concerning numbers
ii) Learn about life and works of ancient Indian and Foreign scientists in mathematical scienc.
iii) Learn the symmetrical behaviour of numbers.
iv) Know solve simultaneous algebraic equations with matrix theory.

Unit 1: Biographies of Remarkable Mathematicians:
A brief introduction to the lives and information on the works of the following Mathematicians: Euler, Lagrange, Gauss, Cauchy, Abel, Galois, Riemann, Hardy, Noether, Ramanujan, Neumann, Wiles, and Bhargava.
[2] Pages 41, 126, 161, 207, 280, 346, and 579-580.
[4] Chapter 1 (pages 1–7), Chapter 5 (pages 182 – 189), Chapter 8 (pages 299 – 306), Chapter 9 (pages 357 – 362),and Chapter 10 (pages 412 – 416).

Unit 2: Functions, Perspective Geometry, Symmetry and Fractals
Basics of Graph Theory, The Königsberg Bridge problem, The four-color map problem, The Möbius strip and the Klein bottle.

Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs.

Perspective and Projection, Perspective geometry**:** Lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot use of perspective and techniques. Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden Ratio, Golden triangle. Shapes and solids, Basic tiling, The regular polyhedron, Importance of Platonic solids and mystical significance to the ancient Greeks; Fractals in nature, Snowflake curves, and Sierpinski triangle.

[3] Chapter 5 (Section 5.5), and Chapter 11 (Section 11.5) Chapter 10 (Sections 10.0, and 10.1 up to page 344)
Chapter 11 (Section 11.2), Chapter 13 (Section 13.1), and Chapter 15 (Section 15.1)
[2] Chapter 1. [3] Chapter 8 (Section 8.5), and Chapter 12 (Pages 418 and 419).
[3] Chapter 12 (Sections 12.0, and 12.1 up to page 399), and Chapter 17 (Sections 17.0 to 17.4)

Unit 3: Solving Systems of Linear Equations using Matrix
Solving systems of linear equations, Gaussian elimination method and row operations, Consistent and inconsistent system, Gauss-Jordon row reduction and reduced row echelon form, Homogenous system, Equivalent systems and row equivalence of matrices, Rank of a matrix, Relation between homogenous system and rank.
[1] Chapter 2 (Sections 2.1 to 2.3).

Text Books:
1.Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Academic Press, Elsevier India Private Limited.
2. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
3. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
4. James, Ioan. (2002). *Remarkable Mathematicians*: *From Euler to von Neumann*. The Mathematical Association of America. Cambridge University Press.