RABINDRANATH TAGORE UNIVERSITY

DEPARTMENT OF MATHEMATICS

Four Year Undergraduate Bachelor of Commerce

AS PER NEP, 2020

DEPARTMENT OF MATHEMATICS,
RABINDRANATH TAGORE UNIVERSITY, HOJAI: ASSAM
Mathematics Syllabus for UG courses, according to NEP2020 (CBCS)

Subject details For First and Second Semester:

Class	Courses	Subject papers	Credits
SEM-I	CORE	MAT-COR-1.1: Calculus	4
	MINOR	MAT-MIN-1.101 Fundamental Calculus	4
	SEC	MAT-SE-1.1 Computer Algebra system	3
	GE	……………………………………	3
	AECC	……………………..	2
	VAC	……………………..	2+2
	VOC/ Minor research project	x	X
			Total credit:20

CLASSES	COURSES	Subject papers	Credits
SEM- II	CORE	MAT-COR-2.1: Algebra	4
	MINOR	MAT-MIN-2.1 Real analysis	4
	SEC	MAT-SE-2.1: R-Programming	3
	GE	……………………………………………	3
	AECC	……..	2
	VAC	……..	2+2
	VOD/MinorProject	x	x
			Total credit:20

Note: *COR -Core; MIN -Minor; SE-skill enhancement; GE-Generic Elective*

Note: Students who exits after first year will be awarded undergraduate certificate (in the field/discipline) if He/She completes a summer internship course of credit-4, in Seco

CLASS	COURSE	SUBJECT PAPERS	Paper credits
SEM-III	CORE(Major)	MAT-COR-3.1:Differential equations MAT-COR-3.2: Real Analysis	4+4
	MINOR	MAT-MIN-3.1: Algebra	4
	SEC	MAT-SE-3.1: Latex and HTML	3
	MD	MAT-MD-3.1 BASICS OF COMPUTER	3
	AECC	……………	2
	VAD	x	x
	VOC/Minor project	x	x
			Total credit=20

CLASS	COURSE	SUBJECT PAPERS	PAPER CREDITS
Sem-IV	CORE(Major)	MAT-COR-4.1: Theory of Real functions MAT-COR-4.2: Abstract algebra MAT-COR-4.3: Multivariate calculus	4x3=12
	DSE-I	(Choose any one) MAT-DSE-4.1	

SEM-IV	(Minor)	Analytical geometry MAT-DSE-4.2 Probability and statistics	4
	SEC	x	x
	GE	x	x
	AECC	……………………	2
	VAD	x	x
	VOC/Minor project	Summer internship	2
			Total credit:20

Note: COR: core subject, MIN: minor subject,
GE/MD: Generic elective/Multidisciplinary subject

SEMESTER-I

MAJOR-1.1
Calculus (including practical)

Course Title : Calculus (including practical)
Course Code : MAJ-MAT-1.1
Nature of Course : MAJOR
Total Credits : 4
Distribution of Marks :(Theory:80)+(Internal Assessment: 15)+(Practical: 25)

Learning objective: The objective of learning the course is to
*give idea of successive differentiation, Leibnitz's theorem and L'Hospital rule for evaluating limit
* to explain various types of reduction formula for integration of trigonometric and exponential functions and applications in finding volume and surface of revolution of curves
*to give the idea of vectors product their applications in physical problems

UNIT 1: (contact hour:15)(20 marks) Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type eax+bsinx, eax+bcosx, (ax+b)n sinx, (ax+b)n cosx, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hopital's rule, applications in business, economics and life sciences. [1]: Chapter 4 (Sections 4.3-4.5 (page 124-157), 4.7). [2]: Chapter 7 (Section 7.8), Chapter 11 (Section 11.1).

UNIT 2: (contact hour:15) (20 marks)Reduction formulae, derivations and illustrations of reduction formulae of the type ∫sinn x dx, ∫cos n x dx, ∫tan n x dx, ∫sec n x dx, ∫(log x)n dx, ∫sinn x cos m x dx, volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. [1]: Chapter 9 (Sections 9.4 (Pages 471-475 (excluding lines in R3))). [2]: Chapter 8 (Sections 8.2-8.3 (pages 532-538 (excluding integrating products of tangents and secants))), Chapter 6 (Section 6.2-6.5 (excluding arc length by numerical methods))

UNIT 3:(contact hour:15) (20 marks)Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law. [1] Chapter 9 (Section 9.3 (pages 468-469)), Chapter 10

Practical / Lab work to be performed on a computer: List of the practical to be done using Matlab / Mathematica / Maple / Scilab / Maxima etc. (Contact hour: 20)(25 marks)

(i). Plotting the graphs of the following functions: ax x , [ ] (greatest integer function), ax b ax b c ax b x x n Z + + ± + n n∈ ± ,| |, | |, , , 1 ( ) ( ) 1 , sin 1 , sin 1 , and , for 0. , log( ), 1/ ( ), sin( ), cos( ), | sin( ) |, | cos( ) |. x ax b xx x xx e x e ax b ax b ax b ax b ax b ax b ± + ≠ ++ + + + + Observe and discuss the effect of changes in the real constants a, b and c on the graphs. 9

(ii). Plotting the graphs of polynomial of degree 4 and 5, the graphs of their first and second derivatives, and analysis of these graphs in context of the concepts covered in Unit 1.

(iii). Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid.

 (iv). Tracing of conic in cartesian coordinates.

(v). Obtaining surface of revolution of curves.

(vi). Graph of hyperbolic functions.

 (vii). Computation of limit, Differentiation, Integration and sketching of vector-valued functions.

 (viii). Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form.

ix). Find numbers between two real numbers and plotting of finite and infinite subset of R

Learning outcomes: After going through the subject students will be able to learn

* apply calculus in real life problems

*idea to find limits of functions

*Idea of vector operations and their applications in physical problem

Internal Assessment: (15 marks)

Through the sessional examination, assignments, class test etc

Text Books: 1. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007. 2. H. Anton, I. Bivens and S. Davis, Calculus (7th Edition), John Wiley and sons (Asia), Pt Ltd., Singapore, 2002.

SEMESTER-I

MINOR-1.1
Fundamental Calculus

Course Title : Fundamental Calculus
Course Code : MIN-MAT-1.1
Nature of Course : MINOR
Total Credits : 4
Distribution of Marks :(Theory:80)+(Internal Assessment: 20)

Learning objectives: The aim of the course is to
*give idea of graph of functions
*the idea of limit of functions and their evaluations
***to learn the technique of successive differentiation, Leibnitz's theorem
and L'Hospital rule for evaluating limit**
*to study Roll's theorem, M.V. Theorem etc and their remainder terms
*idea of functions of several variables

Unit 1: (contact hour: 10) (15 marks)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: (contact hour: 10)(15 marks) Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem. [2] Chapter 1

Unit 3: (contact hour: 15)(20 marks) 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: (contact hour:15)(15 marks) Roll'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:(contact hur:10)(15 marks)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)

Learning outcomes: After going through the subject students will be able to learn the

*Basic concept of functions and their graphs

*Limit and continuity, differentiability of functions

* Tangent and normal's of curves,

*Maximum and minimum of a function.

*know expansion of functions and different form of remainders

*know functions of several variables and there partial derivatives

Internal Assessment: (20 marks)

Through sessional examination, assignment, class test etc.

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-I

SEC-1.1
Computer Algebra Systems and Related Software

Course Title : Computer Algebra Systems and Related Software

Course Code : SEC-MAT-1.1
Nature of Course : SEC
Total Credits : 3
Distribution of Marks :(Theory:50)+(Practical: 25)

Learning objective: The aim of the course is to a preliminary idea about
*computer operations
*calculations through computer
*idea of plotting graph in computer

Unit 1: *(Marks:15)(Contact hours :15)* 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: *(Marks:15)(Contact hours:15)* 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. (Marks: 30)(Contact hours:20)**

Six practicals should be done by each student. The teacher can assign practical from the exercises from [1, 2].

Internal Assessment: (15 marks)

Through the sessional examination, assignment, class test etc.

Learning outcomes: **After going through the course the students will learn**

* to calculate basic arithmetic's through computer in an easy way,

* *to*use algebraic properties in calculation, programming etc

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.

1. Torrence, Bruce F., & Torrence, Eve A. (2009). The Student's Introduction to Mathematica: A   Handbook for Precalculus, Calculus, and Linear Algebra (2nd ed.). Cambridge University Press

SYLLABUS UNDER FYUGP
B.A./B.SC.2ND SEMESTER

SEMESTER-II

MAJOR-2.1
Algebra

Course Title : Algebra
Course Code : MAJ-MAT-2.1
Nature of Course : MAJOR
Total Credits : 4
Distribution of Marks :(Theory:80)+(Internal Assessment: 20)

Learning objective: The objective of the topics is to give* idea about real and complex numbers, DeMoiver's theorem and their applications, *the idea of logical statements, idea of relations and functions and system of linear equations and to solve them through matrix operations.

UNIT-1: *(Marks: 20) (Contact hours: 15)* Polar representation of complex numbers, nth roots of unity, De Moiver's theorem for rational indices and its applications. [1]: Chapter 2

UNIT-2*:(Marks:30)(Contact hours:20)* Statements and logic, statements with quantifier, compound statements, implications, proofs in Mathematic; Sets, operations on sets, family of sets, power sets, Cartesian product; Functions, one-one, onto functions and bisections, Composition of functions, Inverse of a function, Image and Inverse image of subsets; Relation, Equivalence relations, Equivalence classes and partitions of a set, congruence modulo n in integers; Induction Principles, the well-ordering principle, greatest common divisor of integers. [2] Chapters 1 – 5.

UNIT 3: *(Marks:30) (Contact hours:25)* Systems of Linear Equations, row reduction and echelon forms, vector equations, the matrix equation Ax = b, solution sets of linear systems, linear independence, introduction to linear

transformations, the matrix of a linear transformation; Matrix operations, inverse of a matrix, characterizations of invertible matrices; Determinants, Cramer's rule [3]: Chapter 1 (Sections 1.1 – 1.9); Chapter 2 (Sections, 2.1 – 1.3); Chapter 3 (Sections 3.1 – 3.3)

Internal Assessment :(20 marks)

Through sessional examination, assignment,class test etc

*Learning outcome:***After going through this course the students will be able to have**
* A basic idea about real and complex numbers
*Ideas about sets and their algebraic structure
*logical ideas behind the mathematical statements,
*ideas about functions and their operations,
*About matrices and their relations with system of linear equations.
*Various applications of the topics in real life

Text Books: 1. TituAndreescu and DorinAndrica, Complex Numbers from A to …. Z, Birkhauser, 2006.
2. A. Kumar, S. Kumaresan and B.K. Sarma, A Foundation Course in Mathematics, Narosa, 2018.
3. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education Asia, Indian Reprint, 2007.

Reference Books: 1. S. Barnard and J.M. Child, Higher Algebra, Arihant, 2016.

2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (3rd Edition), Pearson Education (Singapore) Pvt. Ltd., Indian Reprint, 2005.

 3. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007

SEMESTER-II

MINOR-2.1
Real Analysis

Course Title : Real Analysis
Course Code : MIN-MAT-2.1
Nature of Course : MINOR
Total Credits : 4
Distribution of Marks :(Theory:80)+(Internal Assessment: 20)

Learning objectives: The main objective of the topic is
*to explain deep understanding of the real line and important terms
*functions and the limit and continuity
*to prove the results about convergence and divergence of sequence and series.

Unit 1: (contact hour:30)(40 marks) 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:**(contact hour:30)(40 marks)** Sequences, Convergent and Cauchy sequences, Subsequences, Limit superior and limit inferior of a bounded sequence, Monotonically increasing and decreasing sequences, Infinite series and their 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 conditional convergence. [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)

Learning outcomes: **After going through this course the students will be able to**

*identify the number system; analyze **the properties of the number line**
*describe various analytical properties of the real number system
*sequence of numbers and their convergence and divergence and test for convergence and divergence.
INTERNAL ASSESSMENT: (20 marks)
Through sessinal examination, assignment, class test etc.

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

Learning Outcomes: After going through the course students will be able to
*Deep understanding of real line
*Intervals of reals
* Convergence and divergence of sequences
* Series of real numbers.
*Applications of these in various physical problems

SEMESTER-II

SEC-2.1
R-Programming

Course Title : R-Programming
Course Code : SEC-MAT-2.1
Nature of Course : SEC
Total Credits : 3
Distribution of Marks :(Theory:50)+(Practical: 25)

Learning Objectives: The objective of the course to give

- A basic idea of R- programming language
- Introduced with various tools in R programming and their uses in writing computer program

Unit 1(*Contact hours:10)*(**8 marks**)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(*Contact hours: 10)*(**7 marks**)Descriptive Statistics and Tabulation Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables. [2] Chapter 4

Unit 3: (*Contact hours:10) (7 marks)*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(*Contact hours:8*) **(8 marks)**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

Learning outcome: After going through the course learner will be able to
*have an idea of R-Programming language
*Use of R-Programming language in solving mathematical problem Practical to be done in the **Computer Lab using Statistical Software R**:
*(Contact hours: 20)***(30 marks)**
[1] Chapter 14 (Exercises 1 to 3) 30 [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/

INTERNALL ASSESSMENT: (15 Marks)
Through sessional examination, assignment, class test etc...
Learning outcome: After going through the course students will learn
*What is R-Programming Language?
*Its various tools to in write computer programs in solving mathematical problems
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 Publication

SEMESTER-III

MAJOR-3.1
Differential Equations (including practical)

Course Title: **Differential Equations (including practical)**
Course Code : MAJ-MATH- 3.1
Nature of Course : Major
Total Credits : 4
Distribution of Marks: 60 **(THEORY) +25 (PRACTICAL)+ 15(INTERNAL ASSESSMENT)**
per week: 3 Lectures, 2 practical, Credits: 4(3+1)

Learning objectives: *The objective of the course is (i) to give idea about differential equations, (ii) formation of differential equations,(iii) to solve differential equation by various methods (iv) to form mathematical model in terms of differential equations, (v) apply mathematical model in physical problem.*

UNIT 1:(Contact hour: 15)(Marks:20) Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. [2] Chapter 1 (Sections 1.1, and 1.6), [3] Chapter 2, [2] Chapter 1 (Section 1.4, pages 35 to 38), and Chapter 2 (Section 2.3). [3] Chapter 3 (Section 3.3, A and B with Examples 3.8, 3.9)
UNIT 2: **(Contact hour:15)(Marks:20)** Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting. [1]

Chapter 2 (Sections 2.1, 2.5, and 2.6), [1] Chapter 2 (Sections 2.7, and 2.8), [1] Chapter 3 (Sections 3.1 to 3.3)

UNIT 3: (Contact hour:15)(Marks:20) General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and nonhomogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters. [2] Chapter 3 (Sections 3.1 to 3.3, Sections 3.4 (pages 172 to 177), and 3.5), [1] Chapter 5 (Sections 5.1, 5.2, 5.4, and 5.9), and Chapter 6 (Sections 6.1 to 6.4).

List of Practical (using any software) :**(Contact hour :10)(Marks:20)**
1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).

Mode of Internal assessment: **(20 marks)**
Through sessional examination, assignment, class test etc.
 Text Books: 1. Barnes, Belinda &Fulford, Glenn R. (2015). Mathematical Modeling with Case Studies, Using Maple and MATLAB (3rd Ed.). CRC Press, Taylor & Francis Group. 2. Edwards, C. Henry, Penney, David E., &Calvis, David T. (2015). Differential Equation 13 and Boundary Value Problems: Computing and Modeling (5th Ed.). Pearson Education. 3. Ross, Shepley L. (2004). Differential Equations (3rd Ed.). John Wiley & Sons. India

Reference Books: 1. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004. 2. Ross, Clay C. (2004). Differential Equations: An Introduction with Mathematica (2nd Ed.). Springer

Learning outcomes: **After going through this course the students will be able to**

*Know about differential equations and its formation,

*Applications of Differential equation in various fields,

* *Forming* mathematical models in the form of differential equations

*to solve various physical problems by mathematical modeling

SYLLABUS UNDER FYUGP
B.A./B.SC. 3RD SEMESTER

SEMESTER-III

MAJOR-3.2
Real Analysis

Course Title: Real Analysis
Course Code : MAJ-MATH- 3.2
Nature of Course : Major
Total Credits : 4
Distribution of Marks: 80 (THEORY) + 20 (INTERNAL ASSESSMENT)

per week:(3 Lectures, 1 Tutorial)

Learning objective: The aim of the course is *to explain deep understanding of the real line and important terms *to prove the results about convergence and divergence of sequences and series

UNIT 1 : *(Marks:20)(Contact hours:20*) Algebraic and order properties of R, absolute value and real line, bounded sets, supremum and infimum, completeness property of R, the Archimedean property, the density theorem, intervals, nested interval theorem. [1] Chapter 2

UNIT-2*:(Marks:30)(Contact hours:20*) Real sequences, limit of a sequence, convergent sequence, bounded sequence, limit theorems, monotone sequences, monotone convergence theorem, subsequences, monotone subsequence theorem, Bolzano Weierstrass theorem for sequences, Cauchy sequences, Cauchy's convergence criterion, properly divergence sequences. [1] Chapter 3

UNIT 3:(Marks:30)(Contact hours:20) Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, root test, integral test, Absolute convergence, rearrangement theorem, alternating series, Leibniz test, conditional (nonabsolute) convergence. [1] Chapter 9 Sections 9.1-3.

Mode of internal assessment: **(20 marks)**

Through sessional examination, assignment, class test etc

Learning outcomes: After going through this course the students will be able to

*identify the number system ,**analyze the properties of the number line**

*describe various analytical properties of the real number system
*sequence of numbers and their convergence and divergence and test for convergence and divergence.

Text Book: 1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons, 2002.

Reference Books: 1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010.

2. A. Kumar and S. Kumaresan, Basic Course in Real Analysis, CRC Press, 2014.

3. K. A. Ross, Elementary Analysis: The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Semester: III

SEMESTER-III

MINOR-3.1
Algebra

Course Title : Algebra
Course Code : MIN-MATH-3.1
Nature of Course : Minor
Total Credits : 4
Distribution of Marks : 80 (End -Sem) + 20 (Sessional)
per week: 3 Lectures, 1 Tutorial , each unit carry equal marks

Learning objective: The objective of the topics is to give* idea functions trigonometric and exponential, roots of roots of quadratic, cubic equation, relation between roots and coefficients, DeMoiver's theorem and their applications*types of matrices, solutions of matrix equations,*Preliminary idea about abstract algebra groop,ring,vector space

Unit 1: **(Contact hour:20)**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 cubic and 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: **(Contact hour:20)**Matrices: Types of matrices, Rank of a matrix, Invariance of rank under elementary transformations, 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: (**Contact hour: 20**) 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)

Mode of Internal Assessment: 20 marks

Through sessional examination, assignment, class test etc.

*Learning outcome:***After going through this course the students will be able to have**
* A basic idea about functions, types of functions
*idea about roots of equations and to write equations from roots
*idea about matrices, matrix operations, solving matrix equations, cayley Hamilton theorem
*idea of abstract thinking

Text Books: 48 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 & Son

SEMESTER-III

MD/GE-3.1
Basics of Computer

Course Title : Basics of Computer
Course Code : MD-MATH-3.1
Nature of Course : Multidisciplinary
Total Credits : 3
Distribution of Marks : 50 (Theory) + 25 (Practical)
per week: 2 Lectures, 1 Tutorial

Learning objective: The aim of the course is to a preliminary idea about
*computer operations
*calculations through computer
*idea of plotting graph in computer

Unit 1: **(Marks:25)(Contact hours :15)** Computer Algebra System , Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot 3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, 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: (**Marks: 15**)(contact hour:10)Elements of Latex; Hands-on-training of Latex, Elementary mathematical typesetting.   [1] Chapters 9, 10.

Unit 3:(Marks:10)(contact hour: 5) HTML, creating simple web pages, images and links. [1] Chapter- 15

Practical: List of the practical to be done using <u>Matlab / Mathematica /</u> Maple (Marks: 25) (Contact hours:20)

Six practicals should be done by each student. The teacher can assign practical from the exercises from [1, 2,3]

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.

2. Torrence, Bruce F., &Torrence, Eve A. (2009). The Student's Introduction to Mathematica: A   Handbook for Precalculus, Calculus, and Linear Algebra (2nd ed.). Cambridge University Press

Learning outcomes: After going through the course the students will learn

*To calculate basic arithmetic's through computer in an easy way,

*To use algebraic properties in calculation, programming etc

Internal assessment: 15 marks

Through sessional exam, assignment, class test etc

SEMESTER-III

SEC-3.1
Latex and HTML (Including practical)

Course Title : Latex and HTML (Including practical)
Course Code : SEC-MATH-3.1
Nature of Course : SEC
Total Credits : 3
Distribution of Marks : 50(Theory)+25(Practical)
per week: 2 Lectures, 2 Practical

Learning objective: The main objective of the course is to *introduce with programming language Latex *with markup language HTML

Unit 1: (Marks: 30)(contact hour:10)Elements of Latex; Hands-on-training of Latex; graphics in Latex; PSTricks; Beamer presentation [1] Chapters 9, 10, 11.

Unit 2:(Marks:20)(contact hour: 10) HTML, creating simple web pages, images and links, design of web pages. [1] Chapter 9-11, 15

Practical: (contact hour:20)(marks: 25)

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

Learning outcome: After going through the course students will learn *to work with Latex *design the web page through HTML

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

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SEMESTER-IV

MAJOR-4.1
Theory of Real Functions

Course Title: Theory of Real Functions
Course Code : MAJ-MATH- 4.1
Nature of Course : Major
Total Credits : 4
Distribution of Marks: 80 (THEORY)+ 20 (INTERNAL ASSESSMENT)

per week: 3 Lectures, 1 Tutorial, each unit carries equal marks.

Learning objective: The main objective of the course is to
- introduce with different type of functions, limit of functions
- continuity of functions and related theorems
- differentiability of functions
- Roll's theorem, MV Theorem, Taylors series etc

UNIT 1: (contact hour: 20)Cluster point or limit point of a set, limits of a function (ε-δ approach), sequential criterion for limits, divergence criteria, limit theorems, one sided limits, infinite limits and limits at infinity. [1] Chapter 4

UNIT 2: (contact hour:20)Continuous functions, sequential criterion for continuity and discontinuity, algebra of continuous functions, continuous functions on intervals, maximum-minimum theorem, intermediate value theorem, location of roots theorem, preservation of intervals theorem, uniform continuity, uniform continuity theorem. [1] Chapter 5

UNIT 3(contact hour:20)Differentiability of a function at a point and in an interval, Caratheodory's theorem, chain rule, derivative of inverse function, Rolle's theorem, mean value theorem, Darboux's theorem, Cauchy mean value

theorem, L'Hospital's rules, Taylor's theorem and applications to inequalities, Taylor's series expansions of exponential and trigonometric functions, ln(1 + x), 1/(ax+b) and n (1+ x) . [1] Chapter 6, and Taylor series as in Section 9.4.

Mode of Internal Assessment: 20 marks

Through sessional examination, assignment, class test etc

Learning outcome: After going through the course students will be able to

- have a god concept about functions, continuity of a function and their geometrical properties
- idea about limit of functions and their evaluation technique
- learn about the differentiability of function
- know about application of Roll's theorem, MV theorem etc .

Text Book: 1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2015. **Reference Books**: 1. Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Indian Edn. 2014.

2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.

3. A.Mattuck, Introduction to Analysis, Prentice Hall, 1999.

4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006

SEMESTER-IV

MAJOR-4.2
Abstract Algebra

Course Title: Abstract Algebra
Course Code : MAJ-MATH- 4.2
Nature of Course : Major
Total Credits : 4
Distribution of Marks: 80 (THEORY)+ 20 (INTERNAL ASSESSMENT)

per week: 3 Lectures, 1 Tutorial, each unit carries equal marks.

Learning objective: The objective of learning the subject is to give

- Abstract idea about group, subgroup, symmetric properties of geometrical objects
- idea of rings, field, integral domains,
- idea of group and ring homomorphism,
- The consequences of these mathematical structures.

UNIT 1: (contact hour: 15) (marks: 15) Definition and examples of group, elementary properties of group, symmetries of a triangle, square, dihedral group, order of a group, order of an element in a group, subgroups, subgroup test, subgroup generated by an element of a group, centre of a group, centralizer, normalizer, product of two groups, cyclic group, properties of cyclic group.
 [1]: Chapters 1, Chapter 2, Chapter 3, Chapter 4.

UNIT 2: (contact hour:15) (marks:15) Permutations, permutation group, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem. Normal subgroup, factor groups.
[1]: Chapter 5 (till end of Theorem 5.7), Chapter 7 (till end of Theorem 7.2), Chapter 9 (Theorem 9.3 and 9.5).

UNIT 3: (contact hour:15)(marks:15) Group homomorphism, properties of homomorphism, isomorphism, kernel of group homomorphism, Cayley's theorem, properties of isomorphism, First, Second and Third isomorphism theorems.
[1]: Chapter 6 (till end of Theorem 6.2), Chapter 10.

UNIT 4: (Contact hour : 15)(Marks: 15) Definition and examples of rings, properties of rings, sub rings, Zero divisors, integral domains and fields, characteristic of a ring, Boolean ring. Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. Ring homeomorphisms, properties of ring homeomorphism,IsomorphismtheoremI,II,III,Polynomial rings,Division algorithm for F[x],remainder theorem, factor theorem, reducibility and irreducibility of polynomials, Eisenstein's Criterion of irreducibility, content of polynomial, primitive polynomial.

[1]: Chapter 12, Chapter 13, Chapter 14, Chapter 15, Chapter 16 and Chapter 17

Learning outcome: After going through the course students will learn

- The abstract terms group, ring, field, integral domains etc.
- The idea of symmetries of geometrical objects.
- The significance of permutation, permutation groups cyclic group, factor group etc
- To apply abstract idea in real life problem
- Abstract idea of ring their examples.

Mode of Internal Assessment: 20 marks

Through sessional examination, assignment, class test etc

Text Book: 1. Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th ed.). Cengage Learning India Private Limited, Delhi.

Reference Books: 1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002. 2. G. Santhanam, Algebra, Narosa Publishing House, 2017. 3. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995. 4. David S. Dummit and Richard M. Foote, Abstract Algebra (2ndEdition), John Wiley and Sons (Asia) Pvt. Ltd, Singapore, 2003

SYLLABUS UNDER FYUGP
B.A./B.SC. 4TH SEMESTER

SEMESTER-IV

MAJOR-4.3
Multivariate Calculus

Course Title: Multivariate Calculus
Course Code : MAJ-MATH- 4.3
Nature of Course : Major
Total Credits : 4
Distribution of Marks: 80 (THEORY)+ 20 (INTERNAL ASSESSMENT)

per week: 3 Lectures, 1 Tutorial, each unit carries equal marks.

Learning objective: The objective of the course is to
* give idea of functions of several variables their derivative, continuity etc
* to make aware of double and triple integral, their physical concept
* application of integrals in physics, economics, understanding the architecture of curves and surfaces

UNIT 1: (20 marks)Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal lines. [1] Chapter 11 (Sections 11.1 and 11.2, 11.3 and 11.4,11.5, 11.6)
15 hrs

UNIT 2:(20 marks) Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl. [1] Chapter 11 [Section 11.7 (up to page 605)], Section 11.8 (pages 610-614)], Chapter13 (Section 13.1)
15 hrs

UNIT 3: (20 marks) Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals. [1] Chapter 12 (Sections 12.1-12.4)   **15 hrs**

UNIT 4:(20 marks) Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral; Surface integrals, Stokes' theorem, The Gauss divergence theorem. [1] Chapter 12 (Sections 12.5 and 12.6) Chapter 13 (Section 13.2, 13.3), [Sections 13.4 (pages 712 to 716), 13.5 (pages 723 to 726)]
15 hrs

Mode of Internal Assessment: 20 marks
Through sessional examination, class test, assignment etc

Learning outcome: After going through the course students will earn about

- the concept of variations of functions of several variables
- understand to maximize and minimize a multivariable function
- Learn the relations among line integral, double integral and triple integral
- familiarize with Green's theorem, Gauss theorem, Stokes theorem etc.
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Textbook: [1] Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011

Reference Books: 1. Marsden, J. E., Tromba, A., & Weinstein, A. (2004). Basic Multivariable Calculus.Springer (SIE).First Indian Reprint. 2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005. 3. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus (3 Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007. 4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

SYLLABUS UNDER FYUGP

B.A./B.SC. 4TH SEMESTER

SEMESTER-IV

MINOR-4.1.1
Analytical Geometry
MINOR (Choose any one-MIN-4.1.1 OR MIN-4.1.2)

Course Title : Analytical Geometry
Course Code : MIN-MATH-4.1.1
Nature of Course : Minor
Total Credits : 4
Distribution of Marks : 80 (End -Sem) + 20 (Sessional)

per week: 3 Lectures, 1 Tutorial , each unit carry equal marks

Learning objective: The main objective of the course is to

- give idea of two and three dimensional co ordinate system,
- equations of straight lines, conics,
- equations of plane, shortest distant between two planes,
- equations of sphere, cylinder etc

UNIT 1: (contact hour: 30) (marks: 40) Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, centre of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal and properties.
 [1] Chapter 3,4, 10

UNIT 2: (contact hour: 30) (marks: 40) Plane, straight lines and shortest distance. Sphere, cone and cylinder, central conicoids, ellipsoid, hyperboloid of one and two sheets, diametral planes, tangent lines, director sphere, polar plane, section with a given centre .
[2] Chapter 4,5,6,7 (up to page 125)

Learning outcomes: After going through the course students will learn

- the idea of two and three dimensional coordinate system,
- the equations of a straight line ,
- equations of parabola, ellipse, hyperbola,
- tangent and normal's ,equations of a plane, distance between two planes,
- Idea of surfaces like elliptical surface, conical surface, section of surfaces by a plane etc.
- Applications to them in practical problems.

Text Books: 1. R. M. Khan, Analytical Geometry of two and three dimension and vector analysis. New Central Book agency 2012.
Reference book:
  1. R. J. T. Bell, Coordinate Solid Geometry, Macmillan, 1983.
Reference Book: 1. E. H. Askwith, the Analytical Geometry of the Conic Sections, Nabu Press (27 February 2012)

B.A./B.SC. 4TH SEMESTER

SEMESTER-IV

MINOR-4.1.2
Probability and Statistics
MINOR (Choose any one-MIN-4.1.1 OR MIN-4.1.2)

Course Title : Probability and Statistics
Course Code : MIN-MATH-4.1.2
Nature of Course : Minor
Total Credits : 4
Distribution of Marks : 80 (End -Sem) + 20 (Sessional)

per week: 3 Lectures, 1 Tutorial , each unit carry equal marks

Learning Objective: The main objective of learning the subject is to
*Give the basic idea of Statistics,
*idea about random variable, sample space, probability etc.
*idea about discrete and continuous variables, distribution of variables etc.
*idea about correlations, joint distributions, conditional distribution etc.

Learning outcome: After going through the course students will be able to
*Have an idea about random variables, events, sample space, continuous and discrete variables etc.*They will get an idea about probability, probability mass function, density function etc..
*They will get idea about Distribution functions such as Bernoulli distribution, Normal distribution etc.
 *They will get idea about joint distribution function, joint probability functions, conditional distribution function etc.

UNIT-1: Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function. [1] Chapter 1 (Sections 1.1, 1.3, 1.5, and 1.6 to 1.9)

UNIT-2: Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. [2] Chapter 5 (Sections 5.2 to 5.4, Sections 5.5, and 5.7) [2] Chapter 6 (Sections 6.2 to 6.4, Sections 6.5, and 6.6)

UNIT-3: Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations. [1] Chapter 2 (Sections 2.1, and 2.3)

UNIT-4 : The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers. [1] Chapter 2 (Section 2.4, and Section 2.5) [2] Chapter 14 (Sections 14.1 to 14.3) [2] Chapter 6 (Section 6.7), and Chapter 4 (Section 4.4) [3] Chapter 2 (Section 2.8, and Exercise 76, page 89)

Text Books: 1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). Introduction to Mathematical Statistics (7th ed.). Pearson Education, Inc. 2. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's Mathematical Statistics with Applications (8th ed.). Pearson. Dorling Kindersley (India). 34 3. Ross, Sheldon M. (2014). Introduction to Probability Models (11th ed.). Elsevier Inc.

Reference Books: 1. Mood, A. M., Graybill, F. A. &Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). McGraw-Hill Education Pvt. Ltd. Indian Edition (2017)