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-C-1.1: Calculus*	*4*
	MINOR	*MAT-M-1.101 Fundamental Calculus*	*4*
	SEC	*MAT-SE-1.1 Computer Algebra system*	*3*
	MD	*MAT-MD-1.1: Basic Mathematics-I*	*3*
	AECC	*…….*	*2*
	VAC	*…….*	*2+2*
	VOC/ Minor research project	*x*	*X*
			Total credit:20

CLASSES	*COURSES*	*Subject papers*	*Credits*
	CORE	*MAT-C-2.1: Algebra*	*4*
		MAT-M-2.1 Real analysis	

SEM- II	***MINOR***		***4***
	SEC	***MAT-SE-2.1: R-Programming***	***3***
	MD	***MAT-MD-2.1 Basic Mathematics-II***	***3***
	AECC	***……..***	***2***
	VAC	***……..***	***2+2***
	VOD/Minor Project	***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 Second year.

SEMESTER-I

CORE CORSE

MAT-COR-1.1: Calculus (including practical)

Total marks: 100 (Theory: 60 Internal Assessment: 20, Practical 20) Total credit:4(L-3,P-2,T-0)

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)(20 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 x x 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: (20 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.

MINOR -I

MAT-MIN-1.1: Fundamental Calculus

Total Marks: 100 (Theory: 80, Internal Assessment: 20) Total credit: 4(L-3,P-0,T-1)

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

MAT-MD-1.1: Basic Mathematics-I

Total Marks: 75 (Th. 60, Int-15) Total Credits: 03 (L-2,P-0,T-1)

Learning Objectives: The objectives of this Course are - *to introduce the basic concepts of sets and mathematical logic in order to develop the critical and logical thinking in solving the problems. *To explain the key concepts of calculus, namely, limits, continuity, differentiability of functions and their various applications.

UNIT-1:(Contact hours:8) (15 Marks) Sets and Logic Sets, subsets, types of set, operations on sets, Cartesian product, Statements, truth values and truth table, negation, conjunction and disjunction, Statements with quantifiers, compound statements, implications, biconditional proposition, converse, contra positive and inverse proposition, propositional equivalence, predicates and quantifier, tautology and contradiction. [1] ch-2(2.1-2.5) , ch-1(1.1-1.5)

UNIT-2 :(Contact hours: 7) (20 Marks) Relation and Functions Relation and functions, types of relation and functions, graphs of functions, compositions of functions and invertible function, Binary operations.

[1] ch-4(4.1-4.4), ch-3(3.1-3.6)

UNIT-3: (Contact hours:15)(20 Marks) Calculus Limits, continuity, Differentiability of function, Derivatives of different types of functions, second order derivatives, rate of change of quantities, increasing and decreasing function, Maxima and Minima, introduction to Integrals, basic properties, definite integrals, Applications of integrals.[2] ch-2(2.2-2.5), ch-3(3.2-3.6), ch-4(4.7), ch-5(5.3)

UNIT-4: (Contact hours:15)(20 Marks) General and particular solutions of differential equations, separation of variables, Homogeneous equations, Linear Differential Equations of first order, General and particular solutions of homogeneous and non-homogeneous linear differential equations of second order with constant coefficients.[3] ch-1(1.1,1.2,1.4,1.5,1.6) ch-3(3.1-3.5)

LEARNING OUTCOMES:

- After the completion of this course, the learner will be able to: Identify the Mathematical objects, to describe social and physical systems
- Use the critical and rational approach for the solution of a problem.
- Describe various algebraic structures onsets
- Apply Calculus in real life problems•

Internal Assessment: (15 Marks)

Through sessional Examination, assignment, class test etc.

Text Books: 1. Kumar A., Kumaresan S., &Sarma, B.K., A Foundation Course in Mathematics, Narosa Publishing House, 2018.

2. Joel Hass,Christopher Hell,Maurice DWeir,Thomas' Calculus,pearson, 14th edition

3. Differential equations and boundary value problems,computing and modeling,C.HenryEdwards,David E.Penney,pearson, third edition

SEC-I

MAT-SE-1.1: Computer Algebra Systems and Related Software

Total marks: 75 (Theory 30, Practical 30, Internal 15) Total credit: 3(L-2, P-2, T-0)

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

SEMESTER-II

CORE COURSE

MAT-COR-2.1: Algebra

Total marks: 100 (Theory: 80 Internal Assessment: 20) Total credit:4(L-3,P-0,T-1),

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. Titu Andreescu and Dorin Andrica, 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

MINOR-II

MAT-MIN-2.1: Real Analysis

Total Marks: 100 (Theory: 80 Internal Assessment: 20) Total credit:4(L-3,P-0,T-1)

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.

INTERNA 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

Generic Elective-II/Multi-disciplinary-II

MAT-MD-2.1: Basic Mathematics-II

Total Marks: 75(Theory: 60, Internal:15) Credits : 03 (L=2, P=0, T=1)

Learning Objectives: The objectives of this Course are-
*To introduce the basic concept of difference operator with their relation
* Interpolation of function for the set of tabulated points.
* To study the basic concepts of probability, random variables.

UNIT-1: **(20 Marks)(Contact hours:15)** Counting Principles Sum and Product rule of counting, permutation and combination, multinomial theorem, Pigeon hole principle, inclusion-exclusion principle, set partitions. [1] Ch 7(7.1- 7.5)

UNIT-2: **(20 Marks)(Contact hours:15)** Finite Differences and Interpolation Introduction, forward difference operator, Operators E & D, backward differences, central differences, Newton' forward and backward interpolation formulae, Lagrange's interpolation formula. [2] ch-1, ch-2

UNIT-3: **(20 Marks)(Contact hours:15)** Probability Introduction to probability, Random experiment, event, axiomatic approach to probability, conditional probability, Multiple theorem on probability,

Bayes' theorem (Statement Only with Applications), random variables and distributions. [3] ch 2(2.1,2.2,2.3), ch 3(3.1,3.2)

INTERNAL ASSESSMENT: (15 Marks)

Through sessional examination, assignment, class test etc.

LEARNING OUTCOMES: After the completion of this course, the learner will be able to-

* To build up a strong foundation of the basic Mathematical tools
* Identify the Mathematical objects to describe social and physical systems

Text Books:

1. Discrete mathematics theory and applications,D.S.Mallik and M.K.Sen,Revised edition 2.
2. Finite difference and Numerical analysis, H.C.Saxena,S chand and company
3. Elements of probability and statistics, A.P.Baissnab,M.Jas, McGraw Hill

Reference books:

1. Rao, G. S., Numerical Analysis. New Age International Publishers, 2003.
2. Berge, C., Principles of Combinatory. New York, 1971.
3. Stewart I., Tall D., The Foundations of Mathematics. Oxford University Press, 2015.
4. Shastry S.S., Introductory Methods of Numerical Analysis, PHI, 2012.

SEC-II

MAT-SE-2.1: R-Programming

Total marks: 75 (Theory 30, internal 15, practical 30) Total credit: 3(L-2,P-2,T-0)

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

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