Mathematics Undergraduate Programmes
2023 May
Tentative Template

Terminologies

Abbreviation	Full-form	Remarks	Related to Major and Minor Courses	
Major (Core)	Main Discipline			
Major (Elective)	Elective Options		related to the Major Discipline	
Minor Stream	Other Disciplines (Inter/ Multidisciplinary) not related to the Major	either from the same Faculty or any other faculty		
OEC	Open Elective Courses/ Generic		**Not** Related to the Major and Minor	
VSEC	Vocational and Skill Enhancement Courses			
VSC	Vocational Skill Courses		~~Not~~ Related to the Major and Minor	Advanced laboratory practical of Major
SEC	Skill Enhancement Courses		**Not** Related to the Major and Minor	
AEC	Ability Enhancement Courses	Communication skills, critical reading, academic writing, etc.	**Not** Related to the Major and Minor	
VEC	Value Education Courses	Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness	**Not** Related to the Major and Minor	

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IKS	Indian Knowledge System	I. Generic IKS Course: basic knowledge of the IKS II. Subject Specific IKS Courses: advanced information pertaining to the subject: part of the major credit.	Subject Specific IKS related to Major	
OJT	On-Job Training (Internship/Apprenticeship)	corresponding to the Major Subject	Related to the Major	
FP	Field projects	corresponding to the Major Subject	Related to the Major	
CC	Co-curricular Courses	Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts	Not Related to the Major and Minor	
CE	Community Engagement and service		Not Related to the Major and Minor	
RP	Research Project	corresponding to the Major Subject	Related to the Major	

SNDTWU 2023 May Programme Structure Template

Structure with Course Titles

(Options related to our area of study to be provided with "OR" for baskets of different types)

	SN	Courses	Type of Course	Credits	Marks	Int	Ext
		Semester I					
10132311 /	1.1	**Calculus-I Algebra-I**	Major (Core)	2+2	100	50	50
1013232 tilte	1.2	**Practical-I**	Major (Core)	2	50	0	50
10432311 / 10432312	1.3	**Mathematics for Business and Management -I *OR* Bio-Mathematics-I *OR* Basic Mathematics for competitive examination**	OEC (Choose any Two)	2+2	100	50	50
1063230	1.4	**Foundation Course in Mathematics -I**	VSC	2	50	50	0
1073230	1.5	**Basic Course in Excel**	SEC	2	50	50	0
1083231	1.6	**English Communication**	AEC	2	50	0	50
1103231	1.7	**Mathematics and India: History and Legacy**	IKS	2	50	0	50
10932301 / 10932302 / 10932303 /	1.8	**Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness**	VEC	2	50	50	0
11432301 / 11432302 / 11432303 /	1.9	**Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts**	CC	2	50	50	0
				22	**550**	**300**	**250**
		Semester II					
20132311 /	2.1	**Calculus-II Algebra-II**	Major (Core)	2+2	100	50	50
2013232	2.2	**Practical-II**	Major (Core)	2	50	0	50
2033231	2.3	**Applied Mathematics**	Minor Stream	2	50	0	50

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20432311 / 20432312	2.4	**Mathematics for Business and Management II *OR* Bio Mathematics II *OR* Advanced Mathematics for Competitive Exam**	OEC (Choose Any Two)	2+2	100	50	50
2063231	2.5	**Foundation Course in Mathematics II**	VSC	2	50	0	50
2073230	2.6	**Advanced Course in Excel**	SEC	2	50	50	0
2083230	2.7	**English Communication Skills**	AEC	2	50	50	0
20932311 / 20932312 / 20932313 /	2.8	**Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness**	VEC	2	50	0	50
21432301 / 21432302 / 21432303 /	2.9	**Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts**	CC	2	50	50	0
				22	**550**	**250**	**300**

Exit with UG Certificate with 10 extra credits (44 + 10 credits)

SNDTWU 2023 May Programme Structure Template

	SN	Courses	Type of Course	Credits	Marks	Int	Ext
		Semester III					
30132311 /	3.1	**Calculus of several variables, Practical**	Major (Core)	2+2	100	50	50
30132312 /	3.2	**Graph Theory, Practical**	Major (Core)	2+2	100	50	50
3033232	3.3	**Differential Equation, Practical**	Minor Stream	4	100	50	50
3043231	3.4	**Mathematics for competitive examination-I**	OEC	2	50	0	50
3063230	3.5	**Mathematical Statistics**	VSC	2	50	50	0
30832311 / 30832312	3.6	**Modern Indian Language Marathi/Hindi/English**	AEC	2	50	0	50
3133230	3.7	**Field Project**	FP	2	50	50	0
31432301 / 31432302	3.8	**NSS/NCC/PE**	CC	2	50	50	0
				22	**550**	**300**	**250**
		Semester IV					
40132311 /	4.1	**Linear Algebra Practical**	Major (Core)	2+2	100	50	50
40132312 /	4.2	**Numerical Methods Practical**	Major (Core)	2+2	100	50	50
40332311 /	4.3	**Matrices Practical**	Minor Stream	2+2	100	50	50
4043231	4.4	**Mathematics for competitive examination-II**	OEC	2	50	0	50
4073231	4.5	**Python Programing**	SEC	2	50	0	50
40832311 / 40832312	4.6	**Modern Indian Language Marathi/Hindi/English**	AEC	2	50	0	50
4173230	4.7	**CEP**	CEP	2	50	50	0
41432301 / 41432302	4.8	**NSS/NCC/PE**	CC	2	50	50	0
				22	**550**	**250**	**300**

Exit with UG Diploma with 10 extra credits (44 + 10 credits)

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	SN	Courses	Type of Course	Credits	Marks	Int	Ext
		Semester V					
50132311/	5.1	**Group Theory, Practical**	Major (Core)	2+2	100	50	50
50132312/	5.2	**Real Analysis, Practical**	Major (Core)	2+2	100	50	50
5013231	5.3	**ODE**	Major (Core)	2	50	0	50
50232311/2 50232312/2	5.4	**Operation Research-I** ***OR*** **Numerical Analysis-I, Practical**	Major (Elective)	2+2	100	50	50
50332311/2 50332312/2 50332313/2	5.5	**Image Processing** ***OR*** **Fluid Dynamics** ***OR*** **Probability and Statistics, Practical**	Minor Stream	2+2	100	50	50
5063230	5.6	**R-Software**	VSC	2	50	50	0
51332301/	5.7	**F.P.**	FP/CEP	2	50	50	0
				22	**550**	**300**	**250**
		Semester VI					
60132311/	6.1	**Ring Theory Practical**	Major (Core)	2+2	100	50	50
60232312/	6.2	**Complex Analysis Practical**	Major (Core)	2+2	100	50	50
6013231	6.3	**PDE**	Major (Core)	2	50	0	50
60332311/2 60332312/2	6.4	**Fourier Series and Boundary Value Problem** ***OR*** **Integral Transform, Practical**	Major (Elective)	2+2	100	50	50
603323112/2 60332312/2 60332313/2	6.5	**Image Processing-II** ***OR*** **Fluid Dynamics-II** ***OR*** **Probability and Statistics-II, Practical**	Minor Stream	2+2	100	50	50
6123233	6.6	**On job training**	OJT	4	100	50	50
				22	**550**	**250**	**300**

Exit with Degree (3-year)

SNDTWU 2023 May Programme Structure Template

SNDTWU 2023 May Programme Structure Template

4-Year Degree with Honors

	SN	Courses	Type of Course	Credits	Marks	Int	Ext
		Semester VII					
70132311/	7H.1	**Data Science-I Practical**	Major (Core)	2+2	100	50	50
70132312/	7H.2	**Artificial Intelligence-I Practical**	Major (Core)	2+2	100	50	50
70132313/	7H.3	**Linear Algebra Practical**	Major (Core)	2+2	100	50	50
7013231	7H.4	**Advanced Calculus**	Major (Core)	2	50	50	0
70332311/2 70332312/2	7H.5	**Advanced Numerical Analysis** ***OR*** **Number Theory, Practical**	Major (Elective)	2+2	100	50	50
7033231	7H.6	**Research Methodology**	Minor Stream (RM)	4	100	50	50
				22	**550**	**300**	**250**
		Semester VIII					
80132311/	8H.1	**Data Science-II Practical**	Major (Core)	2+2	100	50	50
80132312/	8H.2	**Artificial Intelligence-II Practical**	Major (Core)	2+2	100	50	50
80132313/ 80132323	8H.3	**Abstract Algebra Practical**	Major (Core)	2+2	100	50	50
8013232	8H.4	**Metric Space**	Major (Core)	2	50	0	50
80332311/2 80332312/2 80332313/2	8H.5	**Operation Research-II** ***OR*** **Combinatorics** ***OR*** **Coding theory, Practical**	Major (Elective)	2+2	100	50	50
8123233	8H.6	**On Job Training**	OJT	4	100	50	50
				22	**550**	**250**	**300**

SNDTWU 2023 May Programme Structure Template

4-Year Degree with Research

	SN	Courses	Type of Course	Credits	Marks	Int	Ext
		Semester VII					
70132311/	7R.1	**Data Science-I Practical**	Major (Core)	2+2	100	50	50
70132312/	7R.2	**Artificial Intelligence-I Practical**	Major (Core)	2+2	100	50	50
7013236	7R.3	**Fractional Calculus**	Major (Core)	2	50	0	50
70332361/7 70332311/2	7R.4	**Analytical Geometry OR Advanced Numerical Analysis, Practical**	Major (Elective)	2+2	100	50	50
7033236	7R.5	**Research Methodology**	Minor Stream (RM)	4	100	50	50
7163230	7R.6	**Research Project**	Research Project	4	100	100	0
				22	**550**	**300**	**250**
		Semester VIII					
80132311/	8R.1	**Data Science-II Practical**	Major (Core)	2+2	100	50	50
80132312/	8R.2	**Artificial Intelligence-II Practical**	Major (Core)	2+2	100	50	50
8013236	8R.3	**Fractional Differential Equation**	Major (Core)	2	50	0	50
80332361/7 80332311/2	8R.4	**Integral equation OR Operation Research-II, Practical**	Major (Elective)	2+2	100	50	50
8163232	8R.5	**Research Project**	Research Project	8	100	100	100
				22	**550**	**250**	**300**

SNDTWU 2023 May Programme Structure Template

Four Year Degree Program in Mathematics under the Faculty of Science and Technology B.A. / B.Sc. (Honours / Honours with Research)

Preamble, PSOs, COs and Assignment/activities towards CCE

Degree		**B.A. / B.Sc. (Honours/ Honours with Research)**
Major/ Program		**Mathematics (2024 Pattern)**
Preamble		This program's distinctive approach provides fundamental, high-quality knowledge in all significant fields of both pure and applied mathematics. In addition, it offers a comprehensive instructional programme with thoughtfully thought-out credit distribution. Fifty percent of the credits are made up of the major core courses, major specific elective courses, and relevant skill courses. Interdisciplinary minors, open electives, and major-specific IKS courses are added to this course to enhance the curriculum and promote flexibility. Vocational skill courses and skill enhancement courses are designed to enhance practical skills, whereas ability enhancement courses, IKS, and value education courses emphasize overall growth. Managing our daily lives and minimizing chaos using the help of mathematics is a powerful instrument that not just helps us understand the world around us but also serves as an efficient means of cultivating mental discipline. It is anticipated that students will acquire life skills including communication, argumentation, and general social values—all of which are essential for leading a fulfilling, wealthy, and successful life. Additionally, the students are in high demand due to their computational expertise and mathematical modeling models. The curriculum will be updated frequently to meet the needs of business and academia. At different phases of revision, feedback from a range of stakeholders, including parents, alumni, students, and industry professionals, will be gathered. There are eight semesters in the programme. Every semester features a thoughtfully chosen balance of theory and application that offers a wide range of advanced mathematical knowledge and concepts that are beneficial to students for specialized professional work, academic research, and a variety of sectors for wider uses. The National Education Policy 2020's learner-centric curriculum is created in accordance with its guiding principles, allowing students to gain knowledge and skills by projects, internships, hands-on training, AEC, SEC, VEC, and IKS, and other opportunities.

Programme Specific Outcomes (PSOs)		After completing this program, the learner will be able to,
	1	**Demonstrating** basic knowledge of mathematical skills, programming, and computational techniques required for employment.
	2	**Applying** the foundational understanding of mathematical concepts and programming techniques to solve real-life problems effectively.
	3	**Designing** mathematical models for real-life situations by utilizing programming and computational techniques as required.
	4	Critically **analyzing** results obtained from mathematical models and problem-solving processes, evaluating their effectiveness, and identifying areas for improvement.
	5	**Applying** acquired knowledge and skills to solve complex problems, demonstrating the potential to contribute as a researcher in mathematics and related fields.
	6	**Demonstrating** effective communication skills in both written and verbal forms to convey mathematical concepts, research findings, and problem-solving methodologies clearly and effectively.
Eligibility Criteria for Programme		H.S.C. / (10+2) with mathematics or equivalent from a recognized board **or** 10+3 Diploma (any stream) awarded by any state board of technical education.

1.1 Major (Core):- Algebra I

Course Title	**Algebra I**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Recognize** prime numbers, apply Euclid's Lemma, and understand basic properties of divisibility in integers.
	2. **Demonstrating** a deep understanding of Well-Ordering Principle, First Principle of Finite Induction and their implications in number theory.
	3. **Demonstrate** the application of equivalence relations in understanding the concept of partitions.
	4. **Analyze** the properties and relationships between different types of functions, evaluating the conditions for injectivity, subjectivity, and bijectivity.
Module 1(Credit 1) - Integers & Divisibility	
Learning Outcomes	After learning the module, learners will be able to
	1. **Construct** rigorous mathematical proofs for advanced concepts, such as the Well-ordering principle, Euclid's lemma, and the infinite primes.
	2. **Developed** advanced problem-solving skills in number theory, showcasing proficiency in applying the division algorithm, Euclidean algorithm, and binomial theorem
Content Outline	● Well-ordering principle, First principle of finite induction, Binomial theorem for non-negative exponents, Pascal Triangle ● Divisibility in integers, division algorithm, greatest common divisor (G.C.D.) and least common multiple (L. C. M.) of two non-zero integers, basic properties of G.C.D., Euclidean algorithm. ● Primes, Euclid's lemma, Fundamental Theorem of arithmetic, ● The set of primes is infinite, there are arbitrarily large gaps between primes, ● Congruence, definition, and elementary properties.
Module 2(Credit 1) – Relations and Functions	

Learning Outcomes	After learning the module, learners will be able to
	1. **Achieve** mastery in function theory and application, showcasing the ability to evaluate, apply, and create functions.
	2. **Apply** the properties of equivalence relations, such as the concept of equivalence classes and the relationship between partitions and equivalence relations.
Content Outline	● Definition of relation, types of relations, Equivalence relation, Equivalence classes ● Properties such as two equivalences classes are either identical or disjoint, Definition of partition, every partition gives an equivalence relation and vice versa ● Congruence is an equivalence relation on Z, Residue classes and partition of Z, Addition modulo n, Multiplication modulo n, examples ● Definition of function, domain, co-domain and range of a function, composite functions, examples, inverse image of a function, injective, surjective, bijective functions ● Composite of injective, surjective, bijective functions, invertible functions, bijective functions are invertible and conversely

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

1. Students are instructed to choose any five statements associated with the natural number system. Use the principle of finite induction to construct a detailed proof for it. Make a detailed record of the proof. Submit the report to the course instructor. (**CO1)**
2. Students are suggested to create their own five equivalence relations using everyday life examples. This could involve identifying relationships between peoples (e.g. friends, siblings) or any other relevant category. Also, determine the equivalence classes. Make the note of all equivalence classes of all five relations. Submit the report to the course instructor. (**CO3)**

References

1. Burton D.M., Elementary Number Theory, Seventh Edition, McGraw Hill Education (India) Private Ltd.
2. Norman L. (1989) Discrete Mathematics. Revised Edition. Clarendon Press, Oxford.
3. Niven I, Zuckerman. S. (1972). Introduction to the theory of numbers. Third Edition. Wiley Eastern New Delhi.
4. Herstein, I.N. (2006). Topics in Algebra. John Wiley.

5. Bhattacharya P. B. Jain, S.K., Nagpaul, S.R. (1994) Basic Abstract Algebra. New Age International.
6. Anton, H., Bivens, I. Davis, S. (2016). Calculus. (10th edition). Wiley India.

1.2 Major (Core):- Calculus-I

Course Title	**Calculus-I**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Demonstrate** an understanding of sequence of real numbers and their limits through examples. Explain the concept of absolute value and its role in real numbers.
	2. **Evaluate** the convergence and divergence of sequences. Assess the significance of monotone and bounded sequence in mathematical analysis and real world applications.
	3. **Apply** basic algebraic operations to continuous functions and demonstrate understanding of boundedness.
	4. **Apply** theorems to determine the existence of maximum and minimum values for continuous functions on closed intervals.
Module 1(Credit 1) - Sequences of Real Numbers	
Learning Outcomes	After learning the module, learners will be able to
	1. **Articulate** a comprehensive understanding of the algebraic and order properties of real numbers including the completeness and Archimedean property of real numbers.
	2. **Synthesize** knowledge of limit theorems to formulate and prove statements related to the behavior of sequences. Develop proofs independently for advanced limit theorems.
Content Outline	● Algebraic and order properties of real numbers, absolute value, completeness property, Archimedean property, density of rational numbers ● Sequences of real numbers and their limits examples ● Limit theorems (only statements), Limit of some standard sequences $\left(\frac{1}{1+nx}\right) \forall\, x > 0,\ \left(x^{n}\right), \forall x,\ 0< x <1,\ \left(\sqrt[n]{x}\right) \forall\, x > 0$ ● Monotone and bounded sequences ● Subsequences

Module 2(Credit 1) –Limits and Continuity	
Learning Outcomes	After learning the module, learners will be able to
	1. **Demonstrate** a comprehensive understanding of limits and continuity in real-valued functions.
	2. **Apply** advanced limit theorems to analyze and solve real-world problems involving functions.
Content Outline	● Limit of a real-valued function and Limit theorems ● Right hand limit, Left hand limit , Sequential criteria for limit ● Continuous functions ● Algebra of continuous functions, discontinuous functions ● Boundedness theorem (statement), Maximum-Minimum theorem for continuous functions (statement), Intermediate value theorem (statement), examples

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

1. Students are suggested to create five examples of convergent sequence and five examples of divergent sequence. Make the detail note for the solutions of convergence and divergence of the sequences. Submit the report to course instructor.(**CO2)**
2. Consider the function f(x)=$\frac{|x-b|}{x-b}$, x$\in R, b\in [0,\ 100]\cap N$

Discuss the continuity of the function at x= b. List all natural values of **b** for which function f is discontinuous in the prescribed domain. Make the record of detail calculation for any five values of b. Submit the report to the course instructor. (**CO3)**

References

1. Goldberg, R.R. (1915) Methods of Real Analysis, Oxford and IBH.
2. Ghorpade, S., Limaye, B. (2000). A course in Calculus and Real Analysis, Springer International Ltd.
3. Binmore, K.G. (1982). Mathematical Analysis. Cambridge University Press.
4. Bartle, R., Sherbert, D. Introduction to Real Analysis .Third Edition. John Wiley and Sons Inc.
5. Apostol, T.M., Calculus Vol. I, John Wiley, New York.
6. Anton, H. Bivens, I., Davis, .S. (2016). Calculus (10th edition). Wiley India.

Practical Course based on 1.11 and 1.12 [list of the practical will be displayed later]

Course Title	**Practical Course based on 1.11 and 1.12**
Course Credits	**2**
Course Outcomes	**After going through the course, learners will be able to**
	1. **Apply** the concepts of sequences and limits to specific examples, including limit theorems (statements only) and the limits of standard sequences.
	2. **Demonstrate** a foundational understanding of the concepts related to limits, continuity, and basic theorems in calculus.
	3. **Analyze** and evaluate the interconnections between various algebraic concepts and apply them to solve complex problems involving number theory.
	4. Analyze and create mathematical structures involving relations, equivalence relations, and functions, and apply these concepts to solve complex problems.
Learning Outcomes	1. **Analyze** and apply equivalence relations and congruence to solve mathematical problems involving residue classes and partitions, demonstrating a deep understanding of abstract algebraic structures.
	2. **Apply** limit theorems and advanced calculus techniques to solve real-world problems involving sequences of real numbers.
Practical No. 01	**Examples based on Module -1 for Algebra-I**
Practical No. 02	**Examples based on Module -2 for Algebra-I**
Practical No. 03	**Examples based on module -1 and module -2 for Algebra-I**
Practical No. 04	**Examples based on Module -1 for Calculus-I**
Practical No. 05	**Examples based on Module 2 for Calculus-I**
Practical No. 06	**Examples based on Module 1 and Module 2 for Calculus-I**

1.3.A OEC: - Mathematics for Business and Management -I

Course Title	**Mathematics for Business and Management -I**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain basic concepts of averages, ratio, proportion, percentages, profit, and loss.
	2. **Analyze** and solve real-world problems involving advanced applications of averages, ratio, proportion, percentages, profit, and loss.
	3. **Define** and explain the basic concepts of simple and compound interest, annuity, present value, future value, and EMI calculations.
	4. **Analyze** and apply advanced financial calculations involving simple and compound interest, annuity, present value, future value, and EMI in real-world scenarios.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic mathematical concepts of averages, ratio, proportion, percentages, profit, and loss in problem-solving.
	2. **Analyze** and interpret advanced scenarios involving ratios, percentages, and financial calculations.
Content Outline	● Averages ● Ratio and proportion ● Percentages ● Profit and loss
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** financial formulas to compute and interpret basic financial calculations.

	2. **Evaluate** and strategize complex financial scenarios using advanced financial concepts.
Content Outline	● Simple and compound interest ● Annuity ● Present Value and Future Value ● EMI (Equated Monthly Installments)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1) Educational Videos Creation
   Student groups will collaborate to create educational videos explaining basic concepts in averages, ratio, proportion, percentages, profit, and loss. They will share these videos for peer learning and discussions, enhancing understanding through engaging multimedia content.
2) Complex Problem Solving in Finance
   Groups will solve complex real-world problems related to advanced financial calculations and present their solutions. They will discuss their problem-solving methods, offer critical evaluations, and engage in discussions to showcase proficiency in applying advanced financial concepts.
3) Interactive Quizzes/Games
   Students will collaborate in groups to create interactive quizzes or games explaining concepts of simple and compound interest, annuity, present/future value, and EMIs. They will engage peers in learning through these interactive activities, fostering a deeper understanding of financial concepts.
4) Financial Modeling
   Groups will analyze and apply advanced financial calculations to real-world scenarios involving interest, annuity, present/future value, and EMIs. They will present their models, interpretations, and evaluate the reliability and relevance of their solutions.

References

1. Dr. Amarnath Dikshit & Dr. Jinendra Kumar Jain ,Business Mathematics.
2. Padmalochan Hazarika ,Business Mathematics; Sultan chand& sons, Delhi
3. Bari , Business Mathematics; New Literature publishing company, Mumbai

4. J. D. Gupta, P. K. Gupta and Man Mohan, Mathematics for Business Economics:Tata Mc- Graw Hill Publishing Co. Ltd., 1987, Chapters 9 to 11 & 16.

1.3.B. OEC:- **Bio-Mathematics-I**

Course Title	**Bio-Mathematics-I**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Describe** the basic principles of exponential functions, outlining their fundamental properties and how they differ from other types of functions.
	2. **Analyze** and evaluate the behavior and characteristics of exponential functions in various contexts, comparing them with other function types and demonstrating their applications in real-world scenarios.
	3. **Define** and explain the foundational concepts of calculus, including limits and derivatives, and identify the differentiation rules for basic functions.
	4. **Analyze** and apply differentiation techniques to solve complex problems involving various functions and their derivatives.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Analyze** and apply fundamental functions and their properties.
	2. **Solve** equations involving exponential and logarithmic functions.
Content Outline	● Introduction to exponentials ● Functions and graphs ● Logarithm, Functions ● constant function, linear function, Quadratic functions, and equations.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** differentiation rules to various functions.

	2. **Analyze** and interpret derivatives as rates of change.
Content Outline	● Introduction to Calculus ● Limits ● Derivative, Derivatives as a Rate of Change, ● Derivatives of function: Constant function, xn, ex, ax, log x, trigonometric functions ● Differentiation rules: Scalar multiplication, addition, subtraction, product and quotient, simple examples.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Comparative Analysis Presentation (CO1)
   Students will form groups to research and present a comparative analysis illustrating the unique properties of exponential functions compared to linear or polynomial functions. They will showcase graphical representations and real-world examples to highlight the distinctions in behavior and characteristics.
2. Real-life Case Studies (CO2)
   Groups will create case studies demonstrating the behavior and real-world applications of exponential functions in diverse contexts like finance, biology, or physics. They will detail scenarios and explain how exponential functions behave differently and their significance in practical applications.
3. Tutorial Creation (CO3)
   Students will collaborate in groups to create tutorials or video presentations explaining calculus concepts such as limits, derivatives, and differentiation rules. The tutorials will aim for comprehensive coverage and clarity to aid fellow students' understanding.
4. Complex Problem Solving (CO4)
   Groups will solve complex problems involving differentiation techniques applied to functions and their derivatives. They will present their solutions, discussing problem-solving strategies and interpretations of results to showcase their comprehensive understanding.

References

1. Stephen Waner and Steven Constenoble, Applied Calculus: Brooks/Cole Thomson Learning, second edition.
2. Martin Anthony and Norman Biggs, Mathematics for Economics and Finance Methods and Modelling by Cambridge University Press, Cambridge low-priced edition, 2000
3. Dr. Amarnath Dikshit & Dr. Jinendra Kumar Jain.Business Mathematics

4. Padmalochan Hazarika Business Mathematics; Sultan chand& sons, Delhi

1.3.C. OEC :- Basic Mathematics for Competitive Mathematics

Course Title	**Basic Mathematics for competitive examination**
Course Credits	2
Course Outcomes	After completing this course , learner will be able to
	1. **Understand** and apply foundational concepts of the number system, including numerals, place value, basic operations, number series, H.C.F. and L.C.M., as well as simple and decimal fractions, proficiently at a foundational level.
	2. **Analyze**, evaluate, and apply advanced techniques in number manipulation, fraction operations, and fast track formulae effectively, demonstrating critical thinking and proficiency in solving complex mathematical problems at an advanced level.
	3. **Apply** fundamental arithmetic operations involving squares, cube roots, indices, VBODMAS rule, and simplification techniques in solving basic numerical problems.
	4. **Analyze** complex mathematical problem-solving strategies integrating squares, surds, word problems, and advanced mathematical concepts to devise innovative solutions.
Module 1(Credit 1) Numbers	
Learning Outcomes	After learning this module , learner will be able to
	1. **Demonstrate** a comprehensive understanding of the number system, including numerals, place value, face value, basic arithmetic operations, divisibility rules, number series, and types of series.
	2. **Apply** advanced techniques to compute H.C.F. and L.C.M. for larger numbers and polynomials, manipulate complex fractions and decimal operations, and employ sophisticated problem-solving strategies for challenging mathematical questions.
Content Outline	● Number system, Numerals, Face value and place value of the digit in a number, Operations on numbers, Divisibility of numbers ● Number Series, Types of series of numbers ● H.C.F. and L.C.M. ● Simple and decimal fractions, operations on fractions ● Fast track formulae to solve the questions.
Module 2(Credit 1): Numerical Aptitude	

Learning Outcomes	After learning this module , learner will be able to
	1. **Demonstrate** proficiency in performing arithmetic operations involving squares, square roots, cubes, cube roots, indices, surds, and applying the VBODMAS rule, enabling them to solve mathematical problems accurately.
	2. **Develop** the ability to analyze complex word problems, apply appropriate mathematical techniques involving approximation, simplification by rule, and properties of numbers, thereby devising solutions to real-world scenarios integrating numerical concepts effectively.
Content Outline	● Square and Square roots, Cube and Cube roots ● Indices, surds: Properties and operations ● VBODMAS rule, simplification by rule ● Approximation ● Word problems based on numbers

Assignments/ Activities towards Comprehensive Continuous Evaluation (CCE)

1. Students have to solve questions based on above topic from banking examinations
2. VBODMAS rule application

Reference Books

1. Rajesh Verma; Fast track objective arithmetic, Arihant Publications (India) limited, Complete revised edition (Free downloadable e-book).
2. R. S. Aggarwal, Quantitative aptitude for Competitive Examinations.
3. R. S. Aggarwal, Objective Arithmetic (SSC and Railway Exam Special)
4. Arun Sharma, Teach Yourself Quantitative Aptitude.

1.4 VSC :- Foundation Course in Mathematics I

Foundation Course Title	**Foundation Course in Mathematics I**
Course Credits	2
Course Outcomes	After completing this course , learner will be able to
	1. **Explain** the fundamental concepts of sets, set operations, and basic operations related to complex numbers.
	2. **Demonstrate** advanced analytical skills by critically evaluating complex number theories, including geometric representations, polar forms, and applying sophisticated theorems such as De-Moivre's theorem.
	3. **Grasp** the introductory concepts of geometry, understanding equations and the geometrical structures of lines, planes, spheres, and cones
	4. **Analyze** and evaluate the properties and interrelations among various number systems, such as natural, integer, rational, irrational, and real numbers
Module 1(Credit 1) Sets and Complex Numbers	
Learning Outcomes	After learning this module , learner will be able to
	1. **Articulate** and elucidate the fundamental principles underlying sets, set operations, and the basic operations associated with complex numbers, showcasing a clear and comprehensive understanding of these core mathematical concepts.
	2. **Demonstrate** advanced analytical skills by critically evaluating and synthesizing complex number theories, including intricate geometric representations, polar forms, and the application of sophisticated theorems such as De-Moivre's theorem, showcasing a high-level understanding and application of complex mathematical concepts.
Content Outline	● Sets; describing a set, Subsets, Set operations, Indexed collection of sets, Partition, Cartesian product, numerically equivalent sets, Denumerable sets, Uncountable sets ● Cartesian form of complex numbers, Geometrical representation, Sum, Subtraction, Multiplication and Division of complex numbers, Basic algebraic properties, Polar form of complex number,

	properties of modulus and argument, Complex conjugate, De-Moivre's theorem.
Module 2(Credit 1) Number system and Geometry	
Learning Outcomes	After learning this module , learner will be able to
	1. **Differentiate** and apply the properties of natural numbers, integers, rational and irrational numbers, and real numbers.
	2. **Evaluate** the fundamental concepts of geometry, including equations and the geometrical structures of lines, planes, spheres, and cones, showcasing an in-depth understanding and the ability to analyze and interpret complex mathematical properties.
Content Outline	• Natural numbers and properties of natural numbers • Integers, Rational and irrational numbers • Real numbers, properties of real numbers • Geometry: Introduction to equation and geometrical structure of line, Plane, Sphere and Cone.

Assignments/ Activities towards Comprehensive Continuous Evaluation (CCE)

1. Applications of De-Moivres theorem
2. Various equations of geometrical structures are to be given to the students and ask to find their structure.

Reference Books:

1. Gary Chartrand, Albert D. Polimeni and Ping Zhang, Mathematical Proofs, A Transition to Advanced Mathematics, Pearson, 3rd edition.
2. James Ward Brown and Ruel V. Churchill, Complex variables and Applications, Mc-Graw Hill, 7 th edition.
3. Ian Stewart and David Tall, The foundations of Mathematics, Oxford, 2nd edition.
4. Mark Joshi, Proof Pattern, Springer.
5. Shantinarayan, Analytical Solid Geometry, S. Chand and Company Ltd. New Delhi.

1.5 SEC:-Basic Course in Excel

Course Title	**Basic Course in Excel**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Exhibit** an understanding of creating basic charts and graphs and utilizing Excel functions to sort data in ascending and descending order.
	2. **Apply** analytical skills to sort data efficiently in ascending and descending orders using Excel functions.
	3. **Exhibit** knowledge in basic Excel functions such as MIN, MAX, COUNT, and demonstrate competency in utilizing Excel tools like sorting, filtering, and autofill for efficient data management.
	4. **Evaluate** Excel functions beyond basic levels, exploring and integrating advanced features like Cell Comments, Find and Replace, and Page Layout tools
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Utilize** basic Excel functionalities, including performing fundamental arithmetic operations (addition, subtraction, multiplication, division) on varied cell values.
	2. **Demonstrate** expertise in creating visually appealing charts and graphs to interpret intricate data patterns
Content Outline	● Introduction to Excel ● Addition, Subtraction, Multiplication, Division of values in different cells [Basic Arithmetic Operators] ● To prepare basic Charts and Graphs ● To create visually appealing charts and graphs to represent data trends and patterns. ● To sort the data in increasing and decreasing order
Module 2(Credit 1)	

Learning Outcomes	After learning the module, learners will be able to
	1. **Showcase** adeptness in basic Excel functions (e.g., MIN, MAX, COUNT) and utilize essential Excel tools like sorting, filtering, autofill, and Fill Handle for efficient data management.
	2. **Display** advanced proficiency in utilizing Excel functions and tools such as Cell Comments, Find and Replace, and Page Layout, employing them strategically for advanced data analysis and manipulation.
Content Outline	● Cell Comments, Find and Replace and Page Layout ● Various Functions in Excel like MIN, MAX, COUNT ● Use of Sorting and Filtering to display the content from specific group ● Use AutoFill to populate a series of numbers or dates ● Create a series of months or days using the Fill Handle.

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

References

1. Microsoft Excel Bible: The Comprehensive Tutorial Resource
2. Excel: Quick Start Guide from Beginner to Expert (Excel, Microsoft Office)
3. Mark Thompson , Excel 2021

1.6 IKS :- Excel Mathematics and India: History and Legacy

Course Title	**Mathematics and India: History and Legacy**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Demonstrate** a comprehensive understanding of the historical development of mathematics in India
	2. **Articulate** the connections between mathematical developments in India
	3. **Recognize** and Analyze the global impact of Indian mathematical contributions
	4. **Apply** historical and cultural insights gained from the course.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Demonstrate** a comprehensive understanding of the historical evolution of mathematics in India
	2. **Articulate** the interconnections between various mathematical developments in India, elucidating the relationships and influences among different mathematical concepts, disciplines, and mathematicians.
Content Outline	● Vedic Mathematics: History and Origin ● Squares of Numbers ending in 5 [examples only] ● Multiplication of numbers to the base 10, 100 and 1000 [examples only] ● Division by 9 [examples only] ● Multiplication of two; 2 digit numbers [examples only]
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to

	1. **Recognize** and analyze the global impact of Indian mathematical contributions.
	2. **Apply** historical and cultural insights gained from the study of Indian mathematical contributions
Content Outline	● Indian Women and Mathematics: A Brief History ● A Brief Autobiography of any 10 eminent Indian women mathematicians

Assignment/Activities towards Comprehensive Continuous Evaluation (CCE),

References

Semester II

2.1 Major (Core):-Algebra II

Course Title	**Algebra II**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Demonstrate** proficiency in performing standard matrix operations, including addition, subtraction, and multiplication, and understanding basic properties of matrices.
	2. **Analyze** and apply advanced matrix concepts, including determinants, geometrical significance, and the adjoint method for finding inverses.
	3. **Demonstrate** an understanding of systems of linear equations in two and three unknowns, represent them in matrix and augmented forms, and apply elementary solution techniques, including Cramer's rule and Gaussian elimination.
	4. **Analyze** and apply advanced solution techniques, such as Gauss-Jordan elimination, to solve systems of linear equations efficiently.
Module 1(Credit 1) – Matrix and Determinant	
Learning Outcomes	After learning the module, learners will be able to
	1. **Identify** and apply basic properties of matrices and determinants
	2. **Convert** matrices into row echelon and reduced row echelon form.
Content Outline	● Matrix, standard types of matrices: addition, subtraction and multiplication of matrices ● Properties of matrices such as $(AB)^t = B^t A^t$, $(AB)^{-1} = B^{-1} A^{-1}$ ● Determinant, Evaluating determinants by row reduction, Properties of determinants. Geometrical significance of determinant as area and volume. ● Minor, cofactor matrix and adjoint of matrix

	● Elementary matrices, Row echelon and reduced row echelon form of matrix, rank of matrix and adjoint method for finding inverse.
Module 2(Credit 1) - System of Linear Equations	
Learning Outcomes	After learning the module, learners will be able to
	1. **Demonstrate** the ability to find the inverse of invertible matrices using Gauss elimination and Adjoint methods
	2. **Identify** and analyze the consistency of linear system.
Content Outline	● Introduction to systems of linear equations, linear systems in two and three unknowns ● Geometrical significance of system of linear equation ● Matrix form and augmented form of a linear system. ● Solution to the linear system, Cramer's rule. ● Gaussian elimination and Gauss-Jordan elimination. Examples to solve linear system and find the inverse of invertible matrix.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

1. All students are instructed to create invertible matrix of order 3×3 Find the determinant of matrix. Find all minor and cofactor of matrix. Construct the adjoint of the matrix and find the inverse. A concise report summarizing the study's findings is then to be prepared, presented, and submitted by each student. (**CO1)**
2. A group of 2 students should create a system of two linear equations in three variables. Students work together to perform row operations and solve the system. Determine the number of solutions. Make your conclusion on the number of solutions. Submit the detail report to the course instructor. (**CO2)**

References

1. Anton, H., Rorres, C., Elementary Linear Algebra. 11th edition.

2. Datta, K., (2004).Matrix and Linear Algebra. Prentice Hall India Pvt. Limited.

3. Hartman, H., Fundamentals of Matrix Algebra.3rd edition.

4. Lay, D., Linear Algebra and its Applications. Third Edition. Pearson Publications.

5. Hoffman, K., Kunze, R., Linear Algebra. MIT Press.

6. Serge Lang, Introduction to Linear Algebra, Second Edition, Springer.

7. Kumaresan, S., (2000).Linear Algebra, A Geometric Approach. Prentice Hall of India Pvt. Ltd. Additional Reference Books:

8. Artin, M., (1991).Algebra. Prentice Hall of India Private Limited.

9. Hoffman K., Kunze, R. (1971).Linear Algebra, Tata McGraw-Hill, New Delhi.

2.2 Major (Core):- Calculus II

Course Title	**Calculus II**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. **Compute** the derivative of real-valued functions at a given point and understand the basic algebraic rules of differentiation.
	2. **Apply** advanced differentiation techniques, such as the chain rule, Leibniz rule, and implicit differentiation, to solve complex problems involving real-valued functions.
	3. **Explain** and apply Rolle's Theorem, Lagrange's and Cauchy's Mean Value Theorems, and identify monotone functions..
	4. **Apply** advanced calculus concepts, including L'Hôpital's Rule, Taylor's Theorem with Lagrange's form of remainder.
Module 1(Credit 1) – Differentiability of Functions	
Learning Outcomes	After learning the module, learners will be able to
	1. **Demonstrate** a foundational understanding of differentiation by computing derivatives at specific points and explaining the geometrical significance of derivatives.
	2. **Understand** the relationship between continuity and differentiability of the functions
Content Outline	● Differentiation of real valued function of one variable: at a point. ● Geometrical significance of derivative. ● Examples of differentiable and non-differentiable functions ● Differentiable functions are continuous but not conversely ● Algebra of differentiable functions ● Chain rule, Higher order derivatives, Leibniz rule, Derivative of inverse functions, Implicit differentiation (only examples)
Module 2(Credit 1) - Applications of Differentiability	
Learning Outcomes	After learning the module, learners will be able to

	1. **Analyze** and interpret the behavior of functions using concept of critical points, local extrema, concavity
	2. **Explore** the connection between Mean value theorem, continuity and differentiability of functions.
Content Outline	● Rolle's Theorem, Lagrange's and Cauchy's Mean Value Theorems, applications and examples, ● Monotone increasing and decreasing functions, examples. L-Hospital rule (without proof), examples of indeterminate forms, ● Taylor's theorem with Lagrange's form of remainder (without proof), Taylor polynomial and applications. ● Definition of critical point, local maximum/minimum, necessary condition, stationary points, ● Second derivative test, examples, concave/convex functions, point of inflection.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

1. f(x) = $\frac{|x-b|}{x-b}$, x$\in R$, b $\in [0, 100] \cap N$.

   Find left hand and right hand derivative of function f at x= b. Determine the differentiability of f at x=b. Find the set of points at which f is not differentiable. Determine non differentiability geometrically for any five values of b. Plot five different graphs showing non-differentiability. Make detail note and submit the report to course instructor. (CO1)

   A concise report summarizing the study's findings is then to be prepared, presented, and submitted by each student. (**CO1)**

2. Consider the wire of length A unit ($91 \leq A \leq 100$, A $\in N$). Students are instructed to divide the wire into two equal parts such that sum of their square two part is minimum. Record the length of two parts of wire. Do this process for ten different given values of A. Make the report of detail calculations. Submit the report to course instructor(**CO2)**

References

1. Goldberg, R.R(1964) Methods of Real Analysis, Oxford and IBH,
2. Stewart, J. (1994). Calculus, Third Edition, Brooks/ Cole Publishing company.
3. Apostol, T.M. Calculus. volI, Wiley and Sons (Asia) Pte. Ltd.
4. Bartle, R., Sherbert, D. Introduction to Real Analysis (Third Edition) Wiley Student Edition.

5. Narayan, S., Raisinghaniya, M.D. (2012) Elements of Real Analysis. S, Chand& Company Ltd.
6. Apostol, T.M. Calculus Volume-I, John Wiley, New Delhi

Practical Course Based On 2.1 and 2.2

Course Title	**Practical Course Based On 2.11 and 2.12**
Course Credits	**2**
Course Outcomes	**After going through the course, learners will be able to**
	1. **Apply** the concepts of sequences and limits to specific examples, including limit theorems (statements only) and the limits of standard sequences.
	2. **Demonstrate** a foundational understanding of the concepts related to limits, continuity, and basic theorems in calculus.
	3. **Analyze** and evaluate the interconnections between various algebraic concepts and apply them to solve complex problems involving number theory.
	4. **Analyze** and create mathematical structures involving relations, equivalence relations, and functions, and apply these concepts to solve complex problems.
Learning Outcomes	1. **Analyze** and apply equivalence relations and congruence to solve mathematical problems involving residue classes and partitions, demonstrating a deep understanding of abstract algebraic structures.
	2. **Creatively** apply limit theorems and advanced calculus techniques to solve real-world problems involving sequences of real numbers.
Practical No. 01	**Examples based on Module -1 for Algebra- II**
Practical No. 02	**Examples based on Module -2 for Algebra- II**
Practical No. 03	**Examples based on Module -1 and Module -2 for Algebra-II**
Practical No. 04	**Examples based on Module -1 for Calculus- II**
Practical No. 05	**Examples based on Module 2 for Calculus -II**

Practical No. 06	**Examples based on Module 1 and Module 2 for Calculus- II**

2.3.A. OEC:- Mathematics for Business and Management II

Course Title	**Basic Course in Mathematics & Statistics-II**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain basic concepts in preliminary descriptive statistics, such as frequency tables, histograms, and measures of central tendency (mean, mode, median).
	2. **Apply** and critically analyze preliminary descriptive statistics techniques to interpret and analyze data.
	3. **Define** and explain fundamental concepts in basic probability theory, including sample space, events, axioms of probability, conditional probability.
	4. **Analyze** and apply fundamental probability concepts to solve complex real-world problems.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic descriptive statistical tools to summarize data.
	2. **Analyze** and interpret data using preliminary descriptive statistics.
Content Outline	● Preliminary Descriptive Statistics ● Introduction ● Frequency Tables, ● Histograms, ● Measures of Central Tendency: Mean ,Mode and Median.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic probability concepts to analyze simple scenarios.

	2. **Analyze** and solve complex problems using fundamental probability principles.
Content Outline	• Basic Probability theory, • Introduction, • Sample space and events, • Axioms of Probability • Conditional Probability • Addition and Multiplication theorem (without proof) • simple examples.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1) Descriptive Statistics Fair
   Divide students into groups, and assign each group one fundamental concept from descriptive statistics: frequency tables, histograms, mean, mode, or median. The goal is for each group to prepare an engaging and interactive booth or station at a "Descriptive Statistics Fair" to educate others about their assigned concept.
2) Data Analysis Showcase
   Students will form groups and be provided with a dataset related to a specific industry or real-world scenario (e.g., finance, healthcare, marketing). The objective is for each group to analyze the dataset using descriptive statistics techniques and present their findings in a showcase.
3) Visual Guides Creation
   Student groups will create collaborative posters or visual guides detailing basic descriptive statistics concepts. They will present these visuals to the class to facilitate group discussions and deepen understanding
4) Complex Data Analysis
   Groups will analyze complex datasets using preliminary descriptive statistics techniques. They'll present their analyses, discuss implications and limitations, and critically evaluate interpretations to showcase proficiency in applying and analyzing statistical methods.

References

1) D. N. Elhance , Fundamentals of Statistics.
2) S.G. Gupta, Statistical Methods - S. Chand & Co.
3) B Aggarwal, Business Mathematics & Statistics: Ane Book Pvt. Limited
4) STATISTICS by Schaum Series.

2.3.B. OEC:- Bio Mathematics II

Course Title	**Bio-Mathematics-II**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Define** and explain the foundational concepts of probability theory, including sample space, events, and basic axioms of probability.
	2. **Apply** conditional probability and probability theorems to solve complex problems in various scenarios.
	3. **Define** and explain the basic concepts of probability distributions and random variables, including discrete and continuous variables.
	4. **Apply** probability distributions and mathematical expectation to model and analyze real-world problems.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** basic probability concepts to analyze events.
	2. **Utilize** conditional probability and theorems in probability calculations.
Content Outline	● Basic Probability Theory ● Introduction, ● Sample space and events, ● Axioms of probability, ● conditional probability , ● addition and multiplication theorem.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Apply** probability distributions to model random phenomena.

	2. **Calculate** and interpret mathematical expectations in probability distributions.
Content Outline	• Probability Distribution • Random variable, • continuous and discrete variables, • mathematical expectation, • Binomial distribution, • Poisson distribution, • Normal distribution

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1) Interactive Presentations (CO1)
   Student groups will create interactive presentations or infographics explaining fundamental probability theory concepts. They will design interactive elements to engage the audience, ensuring a comprehensive understanding of these concepts.
2) Complex Probability Problem Solving (CO2)
   Students will work collaboratively in groups to tackle complex probability problems involving conditional probability and theorems. They will present solutions, discuss problem-solving strategies, and critically evaluate their approaches for diverse scenarios.
3) Educational Visuals Creation (CO3)
   Groups will collaboratively create educational posters or visual aids explaining probability distributions and random variables. They will present these visuals, encouraging interactive discussions to ensure a comprehensive grasp of these concepts.
4) Real-world Modeling (CO4)
   Students will analyze real-world scenarios and model them using probability distributions and mathematical expectation. They will present their models, interpretations, and implications of findings to demonstrate the application of these concepts in practical scenarios.

References

1) Ronald E Walpole and Raymond H Myers: Probability and Statistics for Engineers and Scientists
2) T. Veerarajan: Probability, Statistics and Random Process, Tata McGraw-Hill Education, 2002.
3) C. Grinstead and J. Snell, Introduction to probability, American Mathematical Society, 1997.
4) Roy D Yates and David J. Goodman, Probability and stochastic processes, John Wiley and Sons, 1998.

2.3.C. OEC:- Advanced Mathematics for Competitive Exam

Course Title	**Advanced Mathematics for competitive examination**
Course Credits	2
Course Outcomes	After completing this course , learner will be able to
	1. **Demonstrate** a foundational understanding of basic mathematical concepts including Average, Percentage, Profit and Loss, Commission and Discount, Simple and Compound Interest, and Ratio and Proportion.
	2. **Analyze** and evaluate the intricacies of mathematical concepts such as Average, Percentage, Profit and Loss, Commission and Discount, Simple and Compound Interest, and Ratio and Proportion.
	3. **Demonstrate** a foundational understanding of mathematical concepts including Mixture and Alligation, Partnership, Problems based on ages, Work and Time, and Work and wages problems.
	4. **Analyze** and evaluate the intricacies of mathematical principles such as Mixture and Alligation, Partnership, Problems based on ages, Work and Time, and Work and wages problems.
Module 1(Credit 1) Numerical Aptitude I	
Learning Outcomes	After learning this module , learner will be able to
	1. **Demonstrate** a proficient understanding of fundamental mathematical concepts such as Average, Percentage, Profit and Loss, Commission and Discount, Simple and Compound Interest, and Ratio and Proportion.
	2. Critically **analyze** and synthesize the intricacies of mathematical principles including Average, Percentage, Profit and Loss, Commission and Discount, Simple and Compound Interest, and Ratio and Proportion
Content Outline	● Average, Percentage ● Profit and Loss ● Commission and Discount ● Simple and compound interest ● Ratio and proportion

Module 2(Credit 1) Numerical Aptitude II	
Learning Outcomes	After learning this module , learner will be able to
	1. **Demonstrate** a proficient understanding of fundamental mathematical concepts such as Mixture and Alligation, Partnership, Problems based on ages, Work and Time, and Work and wages problems.
	2. Critically **analyze** and synthesize the intricacies of mathematical principles including Mixture and Alligation, Partnership, Problems based on ages, Work and Time, and Work and wages problems.
Content Outline	● Mixture and Alligation ● Partnership ● Problems based on ages ● Work and Time ● Work and wages

Assignments/ Activities towards Comprehensive Continuous Evaluation (CCE)

1. Problems from banking examinations are to be asked to be solved to the students.
2. Various quantitative aptitude tests can be solved by students.

Reference Books:

1. Rajesh Verma; Fast track objective arithmetic, Arihant Publications (India) limited, Complete revised edition (Free downloadable e-book).
2. R. S. Aggarwal, Quantitative aptitude for Competitive Examinations.
3. R. S. Aggarwal, Objective Arithmetic (SSC and Railway Exam Special)
4. Arun Sharma, Teach Yourself Quantitative Aptitude.

2.3 VSC:-Foundation Course in Mathematics II

Course Title	**Foundation Course in Mathematics II**
Course Credits	2
Course Outcomes	After completing this course , learner will be able to
	1. **Demonstrate** a comprehensive understanding of mensuration principles, accurately calculating perimeters and areas of geometric shapes, along with surface areas and volumes of three-dimensional figures
	2. Critically **analyze** and synthesize mensuration concepts, evaluating the intricate relationships between shapes and their perimeters, areas, surface areas, and volumes
	3. **Demonstrate** a comprehensive understanding of data interpretation techniques, effectively tabulating and addressing missing data problems.
	4. **Analyze** and evaluate data interpretation methodologies, employing advanced techniques to handle tabulation and missing data complexities effectively.
Module 1(Credit 1) Mensuration and LPP	
Learning Outcomes	After learning this module , learner will be able to
	1. **Compute** and apply mensuration principles, accurately calculating perimeters and areas for various geometric shapes, as well as determining surface areas and volumes of three-dimensional figures.
	2. **Analyze** and synthesize mensuration concepts, evaluating the relationships between geometric shapes and their perimeters, areas, surface areas, and volumes.
Content Outline	● Mensuration: Perimeter of circle, triangle, rectangle and square, Area of circle, square, rectangles and triangles, Surface area of cylinder, sphere, cub and cuboid, Volume of cube, cuboid, sphere, hemisphere, cylinder and cone. ● Trigonometry: Degree and radian, Trigonometric ratios and identities, Angle of elevation and depression, Height and distance problems

Module 2(Credit 1) Data Interpretation and Arithmetic	
Learning Outcomes	After learning this module , learner will be able to
	1. **Interpret** and analyze data, effectively employing techniques for tabulation and resolving missing data issues.
	2. **Assess** and synthesize data interpretation methodologies, exhibiting advanced capabilities in tabulating and addressing complexities in missing data.
Content Outline	● Data Interpretation: Tabulation, Missing data problems, Graphs and Charts, Scater diagram, Table, line, bar and pie diagram ● LPP: Formulation of linear programming problems, Graphical solutions, Cases of unique solution, Solution of LPP by simplex method, Maximization and minimization.

Assignments/ Activities towards Comprehensive Continuous Evaluation (CCE)

1. Applications of angle of elevation and depression
2. Maximization and minimization problems are to be solved.

Reference Books

1. R.S. Aggarwal, Objective Mathematics S. Chand and Co. Ltd.
2. Kapoor V. K., Business Mathematics, Theory and Applications, S. Chand and Sons.
3. Sharma S. K. and Kaur. Gurmeet, Business Mathematics, S. Chand.
4. Thukral. J. K., Bussiness Mathematics, Mayur Publications.
5. Q. Zameerddin, V. K. Khanna and S. K. Bhambri, Business Mathematics- II nd Edition.

2.4 SEC:- Advanced Course in Excel

Course Title	**Advanced Course in Excel**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Grasp** the concepts of Power Query and Power Pivot, comprehending their applications within Excel for data manipulation and analysis.
	2. **Grasp** the concepts of Power Query and Power Pivot, comprehending their applications within Excel for data manipulation and analysis.
	3. **Create** combo charts with multiple chart types on a single graph and utilize Sparklines for miniature chart representations within individual cells.
	4. **Apply** critical thinking to explore advanced features of Hyperlinks, showcasing their understanding and aptitude for utilizing interactivity within Excel for sophisticated data representation and navigation."
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. Perform calculations on arrays of data using functions like SUMPRODUCT or array constants, showcasing an understanding of fundamental data manipulation techniques
	2. Apply Power Query and Power Pivot, demonstrating a high level of understanding and skill in utilizing these tools for complex data analysis and manipulation within the Excel environment.
Content Outline	● Introduction, Basic Arithmetic Operators ● Perform calculations on arrays of data using functions like SUMPRODUCT or array constants ● Power Query and its applications in Excel ● Power Pivot and its applications in Excel
Module 2(Credit 1)	

Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate a proficient understanding of Dynamic Arrays in Excel, showcasing the ability to effectively apply them in various scenarios
	2. Create combo charts combining multiple chart types and implement Sparklines to represent data concisely.
Content Outline	● Dynamic Arrays and its applications in Excel ● Create combo charts with multiple chart types on the same graph ● Use Sparklines for miniaturized charts within individual cells ● Hyperlinks and Interactivity and its Applications

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

References

1) Microsoft Excel Bible: The Comprehensive Tutorial Resource
2) Excel: Quick Start Guide from Beginner to Expert (Excel, Microsoft Office)
3) Excel 2021 by Mark Thompson

2.6 Minor:- Applied Mathematics

Course Title	**Applied Mathematics**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to
	1. **Demonstrate** a foundational understanding of the basic applications in Cryptography using 2 x 2 matrices, and will effectively apply this knowledge towards balancing chemical equations
	2. **Analyze** the intricate nature of Ramanujan Squares (3 x 3) through detailed examples, showcasing advanced analytical skills in mathematical concepts.
	3. **Prepare** for effective communication of mathematical ideas and solutions, both in written and oral form.
	4. **Aware** others about the applications of mathematical concepts in emerging technologies and fields.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	1. **Grasp** the fundamentals of the pagerank algorithm and its practical uses, along with an understanding of Ramanujan Squares (3 x 3) through specific examples."
	2. **Showcase** a comprehensive understanding of the pagerank algorithm's diverse applications and exhibit advanced analytical skills in comprehending Ramanujan Squares (3 x 3) through detailed and intricate examples.
Content Outline	• Applications in Cryptography (2 x 2 matrix only) • Applications towards balancing chemical equations • Introduction to Page rank algorithm and its applications • Introduction to Ramanujan Square (3 x3) and example
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to

	1. **Demonstrate** a foundational understanding of Linear Programming Problem (L.P.P.) formulation, and proficiently apply solution methods including the North-West Corner Method, Least Cost Method, and Vogel's Approximation Method (VAM) for basic problem-solving.
	2. **Exhibit** advanced analytical skills in selecting and justifying the most appropriate method for specific scenarios and critically assessing their results for optimization.
Content Outline	• Introduction and Formulation of L. P. P. • North – West Corner Method • Least Cost Method • Vogel's Approximation Method (VAM)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

References

1) Applied Finite Mathematics by R. Sekhon and R. Bloom, Libre Texts.
2) Elementary Linear Algebra by Howard Anton, Chris Rorres, 11th Edition.
3) Operations Research by Hamdy A. Taha