Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus For

B.Sc. (Mathematics)

(Based on NEP 2020 framework)

(To be implemented from the Academic Year 2023-24)

Eligibility

As per the eligibility circular of SPPU

Credit System :

As per the GR No. एनईपी-2022/प्र.क्र.09/विशी -3/शिकाना dated : 20 April 2023

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree-Honours **Or** Bachelor's Degree-Honours with Research	160	176	8	4

Pattern of examination :

Continuous Internal Examination :
10 M : Field work / Practical
30 M : Online Objective examination / Practical
End Semester Examination : 60 M descriptive Examination

End Semester Examination Question Paper Pattern :

Mode : Descriptive
Total Marks : 60
Total questions : 5 : 12 Mark each
Each question contains either 3 or 4 marks questions with maximum 2 option questions

Standard of passing

< 40 % marks : Fail
Separate passing for Internal and External examination.
CIE passing : 16 marks and above
ESE passing : 24 marks and above

ATKT rules
FY to SY progression : 70 % credits should be completed
SY to TY progression : 50 credits should be completed

Award of Class :
"O" : Outstanding : Grade point 10 : % 80-100
"A+" : Excellent : Grade point 9 : % 70-79
"A" : Very Good : Grade point 8 : % 60-69
"B+" : Good : Grade point 7 : % 55-59
"B" : Above Average : 6 : % 50-54
"C" : Average : Grade point 5 : % 45-49
"P" : Pass : Grade point 4 : %40-44
"F" : Fail : Grade point 0 : % 0-39
"Ab" : Absent : Grade Point 0

Scoring :

CIE Score	ESE Score	Result
<40%	< 40%	Fail
<40 %	>=40%	Fail
>=40%	<40 %	Fail
>=40%	>=40%	Pass

Semester 1 (First Year) Level 4.5

Course Type	Course	Course Code	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 2)	Major Paper 1 (Theory)	**23ScMatU 1101**	Algebra	2	4	40	60	100
	Major Paper 2 (Practical)	**23ScMatU 1102**	Lab course on 23ScMatU 1101	4	2	20	30	50
Major Electives	-							
Minor	-							
OE (2 + 2)	Theory	**23ScMatU 1401**	Fundamentals of Mathematics	2	4	40	60	100
		23CoCopU1402	Democracy, Election and Governance	2				
VSC (2)	Major Specific Practical I	**23ScMatU 1501**	Lab Course on Logic	4	2	20	30	50

SEC (2)	Skill Paper 1 (Practical)	**23ScMatU 1601**	Lab Course on Analytical Geometry	4	2	20	30	50
AEC(2),	MIL	**23CpCop U1701 / 23CpCop U1702**	MIL-I (Hindi) / MIL-I (Marathi)	2	2	20	30	50
VEC (2)	EVS Theory	**23CoCop U1801**	Environment Science I	2	2	20	30	50
IKS (2)		**23CpCop U1901**	Generic IKS	2	2	20	30	50
CC (2)	CC-I Course	**23CoCop U1001**	Online Course Based on Yoga	2	2	20	30	50
Total				28	22	220	330	550

Semester 2 (First Year) Level 4.5

Course Type	Course	Course Code	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 2)	Major Paper 3 (Theory)	**23ScMatU2101**	Calculus	2	4	40	60	100
	Major Paper 4 (Practical)	**23ScMatU2102**	Lab Course on 23ScMatU2101	4	2	20	30	50
Major Electives	-							
Minor	Minor Paper I (Practical)	**23ScMatU2301**	Lab Course on Linear Algebra	4	2	20	30	50
OE (2 + 2)	Theory	**23ScMatU2401**	Business Mathematics	2	4	40	60	100
		23CoCopU2402	Fundamentals of Music	2				
VSC (2)	Major Specific Practical II	**23ScMatU2501**	Lab Course on Discrete Mathematics	4	2	20	30	50

SEC (2)	Skill Paper 1I (Practical)	**23ScMat U2601**	Lab Course on Computational Geometry	4	2	20	30	50
AEC(2),	English Theory	**23CoCop U2703**	English Communication Skills I	2	2	20	30	50
VEC (2)	EVS Theory	**23CoCop U2801**	Environment Science II	2	2	20	30	50
IKS (2)								
CC (2)	CC-II Course	**23CoCop U2001/ 23CoCop U2011/ 23CoCop U2021/ 23CoCop U2031/ 23CoCop U2041/ 23CoCop U2051/ 23CoCop U2061/ 23CoCop U2071**	Physical Education / Cultural Activities,/ NSS/ NCC/ Fine Arts/ Applied Arts/ Visual Arts/ Performing Arts	2	2	20	30	50
Total				**30**	**22**	**220**	**330**	**550**

Semester 3 (Second Year) Level 5

Course Type	Course	Course Code	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4)	Major Core Paper 5 (Theory)	**23ScMatU3101**	Multivariate Calculus	4	4	40	60	100
	Major Paper 6 (Practical)	**23ScMatU3102**	Lab Course on 23ScMatU3101	4	2	20	30	50
	Major Paper 7 (Theory) Major Specific IKS	**23ScMatU1901**	Ancient Indian Mathematics	2	2	20	30	50
Major Electives	-							
Minor (4)	Minor Paper II (Theory + Practical)	**23ScMatU3301**	Discrete Mathematics (T+P)	2 4	4	40	60	100

OE (2)	Theory	**23ScMatU3401**	Financial Mathematics	2	2	20	30	50
VSC (2)	Major Specific Practical III	**23ScMatU3501**	Lab Course on Computer Oriented Numerical Methods	4	2	20	30	50
SEC (2)	--		--	--	--	--	--	--
AEC(2)	Theory	**23CoCop3703**	English Communication Skills II	2	2	20	30	50
VEC (2)	--		--	--	--	--	--	--
FP/CEP (2)	FP –I	**23ScMatU3002**	Field Project - I	4	2	20	30	50
CC(2)	CC III	**23CoCop3001**	Fitness	2	2	20	30	50
Total				**32**	**22**	**220**	**330**	**550**

Semester 4 (Second Year) Level 5

Course Type	Course	Course Code	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4)	Major Core Paper 7 (Theory)	**23ScMatU 4101**	Linear Algebra	4	4	40	60	100
	Major Paper 8 (Practical)	**23ScMatU 4102**	Lab Course on 23ScMatU4101 and SciLab	8	4	40	60	100
Major Electives	-							
Minor (4)	Minor Paper III (Theory + Practical)	**23ScMatU 4301**	Elementary Calculus (T+P)	2 4	4	40	60	100
OE (2)	Theory	**23ScMatU 4401**	Basics of Operations Research	2	2	20	30	50
VSC (2)	--		--	--	--	--	--	--
SEC (2)	Skill Paper III (Practical)	**23ScMatU 4601**	Lab Course on Vector Calculus	4	2	20	30	50

AEC(2),	Theory	**23CoCop4701/ 23CoCop4702**	MIL-II (Hindi) / MIL-II (Marathi)	2	2	20	30	50
VEC (2)	--		--	--	--	--	--	--
IKS (2)	--		--	--	--	--	--	--
FP / CEP(2)	CEP –I	**23ScMatU4003**	Community Engagement Project	4	2	20	30	50
CC(2)	CC-4	**23CoCop4001**	Health and Wellness	2	2	20	30	50
Total				**32**	**22**	**220**	**330**	**550**

Semester 5 (Third Year) Level 5.5

Course Type	Course	Course Code	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total

Major Mandatory (4 + 4 + 2)	Major Core Paper 9 (Theory)	**23ScMatU5101**	Real Analysis	4	4	40	60	100
	Major Paper 10 (Theory)	**23ScMatU5102**	Abstract Algebra	4	4	40	60	100
	Major Paper 11 (Practical)	**23ScMatU5103**	Lab Course on 23ScMatU5101 & 23ScMatU5102	4	2	20	30	50
Major Electives	Elective I (Theory + Practical)	**23ScMatU5201**	Operations Research (T+P)	2 4	4	40	60	100
	Elective II (Theory + Practical)	**23ScMatU5202**	Metric Spaces (T+P)	2 4	4	40	60	100
Minor (4)	Minor Paper IV (Theory + Practical)	**23ScMatU5301**	Ordinary Differential Equations (T+P)	2 4	4	40	60	100
OE (2)	--		--	--	--	--	--	--
VSC (2)	Major Specific Practical IV	**23ScMatU5501**	Lab Course on Latex	4	2	20	30	50
SEC (2)	--		--	--	--	--	--	--
AEC(2),	--		--	--	--	--	--	--
VEC (2)	--		--	--	--	--	--	--
IKS (2)	--		--	--	--	--	--	--

FP / CEP(2)	FP –II	**23ScMatU 5002**	Field Project - II	4	2	20	30	50
Total				**38**	**22**	**220**	**330**	**550**

Semester 6 (Third Year) Level 5.5

Course Type	Course	Course Code	Course / Paper Title	Hours /Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4 + 2)	Major Core Paper 12 (Theory)	**23ScMatU 6101**	Complex Analysis	4	4	40	60	100
	Major Paper 13 (Theory)	**23ScMatU 6102**	Differential Equations	4	4	40	60	100
	Major Paper 14 (Practical)	**23ScMatU 6103**	Lab Course on 23ScMatU6101 & 23ScMatU6102	4	2	20	30	50
Major Electives	Elective III (Theory + Practical)	**23ScMatU 6201**	Number Theory (T+P)	2 4	4	40	60	100
	Elective IV (Theory + Practical)	**23ScMatU 6202**	Laplace Transforms and Fourier Series (T+P)	2 4	4	40	60	100

Minor (4)	Minor Paper V (Theory + Practical)	**23ScMat U6301**	Numerical Methods and its applications (T+P)	2 4	4	40	60	100
OE (2)	--		--	--	--	--	--	--
VSC (2)	--		--	--	--	--	--	--
SEC (2)	--		--	--	--	--	--	--
AEC(2),	--		--	--	--	--	--	--
VEC (2)	--		--	--	--	--	--	--
IKS (2)	--		--	--	--	--	--	--
FP / CEP(2)	--		--	--	--	--	--	--
OJT(4)	OJT	**23ScMatU 6004**	On Job Training	8	4	40	60	100
Total				**38**	**22**	**220**	**330**	**550**

OE : Open Elective
AEC: Ability Enhancement Course
VEC: value Education Courses
CC : Co-Curricular Courses
IKS : Indian Knowledge System
OJT : On Job Training
FP : Field Project
VSC : Vocational Skill Courses
CEP : Community Engagement Project

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code : 23ScMatU3101 **Course Name : Multivariate Calculus**
Teaching Scheme: TH: 4 Hours/Week **Credit : 04**
Examination Scheme: CIA : 40 Marks **End-Sem : 60 Marks**

Pre-requisite Courses:

- Basic knowledge of Limits, Continuity, Derivatives and Integration of functions of one variable.
- Basic knowledge of curves and surfaces.

Course Objectives:

- The aim of this course is to study the concept of Limits, Continuity, Partial derivatives of functions of two or three variables.
- To study the methods of evaluation of double and triple integration.
- To study the double integrals in polar form.
- To study the applications of double and triple integration.

Course Outcomes:

On completion of the course, student will be able to understand –

- The evaluation of limits of functions and continuity of functions of two and three variables.
- The use of partial derivatives and differentiability in other subjects.
- The applications of extreme values.
- The methods of evaluating double and triple integration using rectangular coordinates, polar coordinates etc.
- The method to calculate area of bounded region in two dimensional space, surface and volume of closed and bounded regions in three dimensional space.

Course Contents

Chapter 1	Limits and Continuity of functions of two and three variables	10 lectures
	• Functions of several variables, graphs and level curves of functions. • Limits and continuity.	
Chapter 2	Partial Derivatives	5 lectures
	• Introduction. • Second order partial derivatives. • Mixed derivative theorem. • Partial derivatives of higher order.	
Chapter 3	Differentiability	15 lectures
	• Introduction. • Conditions for differentiability. • Increment theorem for functions of two variables. • Linearization and differentials. • Chain rule.	
Chapter 4	Taylor's theorem and Extreme values	10 lectures
	• Taylor's theorem for functions of two variables. • Extreme values, 1^{st} derivative test. • 2^{nd} derivative test for local extreme values. • Lagrange's multipliers method for finding extreme values of one constraint function.	

Chapter 5	Multiple Integrals	20 lectures
	● Double integral over rectangle, Fubini's theorem for calculating double integrals. ● Double integrals over general regions. ● Change of order of integration. ● Double integral in polar form. ● Substitution method in double integrals. ● Triple integration in rectangular coordinates. ● Substitution method using spherical and cylindrical coordinates in triple integration. ● Applications to find area and volumes.	
	Total Lectures	**60 Lectures**

Reference Books :

1. Mathematical Analysis, (Fifth edition) by S.C. Malik, Savita Arora, New Age International Publishers (2017).
2. A course of Mathematical Analysis, (Revised edition) by Shanti Narayan and P.K. Mittal, S.Chand and Company Pvt. Ltd. (1998)
3. T.M. Apostol, Calculus Volume II (2^{nd} Edition) John Wiley, New York (1967).

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code :23ScMatU3102 Course Name : Lab Course on 23ScMatU3101

(Section - I)

Teaching Scheme: PR: 4 Hours/Week **Credit : 02**
Examination Scheme: CIA : 20 Marks **End-Sem : 30 Marks**

Pre-requisite Courses:

- Basic knowledge of Limits, Continuity, Derivatives and Integration of functions of one variable.
- Basic knowledge of curves and surfaces.

Course Objectives:

- The aim of this course is to study the concept of Limits, Continuity, Partial derivatives of functions of two or three variables.
- To study the methods of evaluation of double and triple integration.
- To study the double integrals in polar form.
- To study the applications of double and triple integration.

Course Outcomes:

On completion of the course, student will be able to understand –

- The evaluation of limits of functions and continuity of functions of two and three variables.
- The use of partial derivatives and differentiability in other subjects.
- The applications of extreme values.
- The methods of evaluating double and triple integration using rectangular coordinates, polar coordinates etc.
- The method to calculate area of bounded region in two dimensional space, surface and volume of closed and bounded regions in three

dimensional space.

Course Contents

Practical 1 : Limits.

Practical 2 : Continuity.

Practical 3 : Mixed partial derivatives.

Practical 4 : Partial derivatives.

Practical 5 : Differentiation.

Practical 6 : Conditions of differentiability.

Practical 7 : Applications of differentials.

Practical 8 : Extreme values.

Practical 9 : Classification of extreme values.

Practical 10 : Lagrange's multipliers method.

Practical 11 : Double integration in rectangular coordinates.

Practical 12 : Double integration in polar coordinates.

Practical 13 : Change of order of integration.

Practical 14 : Triple integration in rectangular coordinates.

Practical 15 : Triple integration in spherical coordinates.

Reference Books :

1. Mathematical Analysis, (Fifth edition) by S.C. Malik, Savita Arora, New Age International Publishers (2017).
2. A course of Mathematical Analysis, (Revised edition) by Shanti Narayan and P.K. Mittal, S.Chand and Company Pvt. Ltd. (1998)
3. T.M. Apostol, Calculus Volume II (2^{nd} Edition) John Wiley, New York (1967).

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU3901 Course Name: Ancient Indian Mathematics
Teaching Scheme: TH: 2 Hours/Week Credit: 02
Examination Scheme: CIA: 20 Marks End-Sem: 30 Marks

Pre-requisites: Basic operations of arithmetic.

Course Objectives:

- To understand the glorious history of Mathematics.
- To understand the valuable contribution by Indian mathematicians in the universe.

Course Outcomes:

- This course will help the students to understand the easy methods for arithmetic operations.
- Students have the opportunity to elaborate and extend their knowledge of mathematics.

Course Contents

Unit 1	History of Mathematics	15 lectures
	• What is Mathematics • Skills to learn Mathematics • Ancient Indian Mathematics • Contribution of ancient Indian mathematicians	
Unit 2	Vedic Mathematics	15 lectures
	• Arithmetical Computations, Multiplication, Division • Factorization • Simultaneous Simple Equations • Quadratic and Cubic Equations • Divisibility • Elementary Squaring and Cubing • Square roots and Cube roots	

Reference Books:

1. Colebrooks Translation of The LILAVATI by H. C. Banerji, Second edition, The Book company Ltd., 1927.
2. Geometry according to Sulabh Sutra by R. P. Kulkarni, Vaidika Samsodhana Mandala, 1983.
3. https://www.cuemath.com/learn/pingala-mathematician/ (03/06/2023)
4. The Aryabhatiya of Aryabhata: An ancient Indian work on Mathematics and Astronomy by Walter Eugene Clark, The University of Chicago Press, 1930.
5. A modern introduction to Ancient Indian Mathematics by T. S. Bhanu Murthy, New Age International, 1993.

6. Vedic Mathematics by Jagadguru Swami Sri B. K. Tirthaji Maharaj, Motilal Banarsidass Publishers Pvt. Ltd., Delhi, 1992.
7. https://en.wikipedia.org/wiki/Indian_mathematics (02/06/2023).
8. https://motion.ac.in/blog/top-10-famous-indian-mathematicians-and-their-contributions/ (02/06/2023).

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU3301 **Course Name:**

Discrete Mathematics

(Section - I)

Teaching Scheme: TH: 2 Hours/Week **Credit: 2**

Examination Scheme: CIA: 20 Marks **End-Semester: 30 Marks**

Prerequisites:

- Sets.

Course Objectives:

The aim of this course is

- To check equivalence of statements.
- To check the statements for tautology, contradiction and contingency.
- To study methods of proofs.
- To study more generalized counting principles.
- To study linear homogeneous recurrence relations.

Course Outcomes:

On completion of the course, student will be able to :-

- Use the concept of logic in other mathematical courses.

- Apply different methods of proofs.
- Solve problems based on counting principles.
- Solve linear homogeneous recurrence relations.

Course Contents:

Chapter 1	**Propositional Logic and Predicates**	6 lectures
	● Propositional logic. ● Truth Tables ● Propositional Equivalences. ● Predicates and Quantifires. ● Nested quantifires.	
Chapter 2	**Methods of Proofs**	8 lectures
	● Method of Induction. ● Method of Contradiction. ● Methods of Contraposition.	
Chapter 3	**Counting Technique**	8 lectures
	● The sum rule and product rule. ● Permutations and Combinations without repetition. ● Permutations and Combinations with repetitions. ● Partition ● Inclusion-Exclusion Principle	
Chapter 4	**Graphs**	8 lectures
	● Introduction. ● Subgraphs.. ● Operations on graphs. ● Trees	
	Total Lectures	**30**

Reference Books:

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen, Seventh Edition,
   McGraw Hill, 2011.
2. Discrete Mathematics Structure by Bernard Kolman, Robert Busby, Sharon Cutler
   Ross, Nadeem-ur-Rehman, Pearson Education (6^{th} Edition), 2009.
3. Applied Combinatorics by Alan Tucker, Wiley Publication, Fourth Edition, 2001.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU3301 **Course Name:**

Discrete Mathematics

(Section - II)

Teaching Scheme: 4 Hours/ Week **Credit: 2**

Examination Scheme: CIA: 20 Marks **End-Semester:30 Marks**

Prerequisites:

- Sets.

Course Objectives:

The aim of this course is

- To check equivalence of statements.
- To check the statements for tautology, contradiction and contingency.
- To study methods of proofs.
- To study more generalized counting principles.
- To study linear homogeneous recurrence relation.

Course Outcomes:

On completion of the course, student will be able to :-

- Use the concept of logic in other mathematical courses.
- Apply different methods of proof.
- Solve problems based on counting principles.
- Solve linear homogeneous recurrence relation.

Course Contents:

Practical 1: Propositions

Practical 2: Truth Tables

Practical 3: Tautology, Contradiction and Contingency
Practical 4: Applications of logic
Practical 5: Predicates and Quantifiers
Practical 5: Validity of arguments
Practical 6: Methods of Induction
Practical 7: Proofs by Contradiction
Practical 8: Proofs by Contraposition
Practical 9: Counting principles
Practical 10: Arrangement and selection without repetition
Practical 11: Arrangement and selection with repetition
Practical 12: Partition
Practical 13: Inclusion-Exclusion Principle
Practical 14: Operations on Graphs
Practical 15: Trees

Reference Books:

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen, Seventh Edition,
   McGraw Hill, 2011.
2. Discrete Mathematics Structure by Bernard Kolman, Robert Busby, Sharon Cutler
   Ross, Nadeem-ur-Rehman, Pearson Education (6^{th} Edition), 2009.
3. Applied Combinatorics by Alan Tucker, Wiley Publication, Fourth Edition, 2001.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU3401
Course Name: Financial Mathematics
Teaching Scheme: TH: 2 Hours/Week
Credit: 02
Examination Scheme: CIA: 20 Marks End-Sem: 30 Marks

Prerequisites: Basic knowledge of derivatives, matrices, linear equations, elementary statistics, principles of economics

Course Objectives: The aim of this course is to study

- Computational skills necessary to implement pricing, hedging, trading and risk management tools.
- Mathematical modeling techniques used in finance.
- How to improve your personal skills, including logical reasoning, quantitative analysis.
- How to apply mathematical concepts in financial models, economics.

Course Outcomes: On completion of the course, student will able to

- Apply the concepts of financial mathematics in Actuarial science to study of assessing risk in insurance and finance also in, Data mining, Data Science, Econometrics.
- Apply the concepts of calculus in finance related models.
- Apply the mathematical concepts in different financial contexts.
- Design the quantitative methodologies and techniques useful in investment banks and other financial institutions.

Course Contents:

Unit 1	**Mathematical models in economics**	**06 Lectures**
	• Introduction • A model of the market	

	• Market equilibrium and excise tax.	
Unit 2	**The elements of finance and the cobweb model**	**08 Lectures**
	• Interest and capital growth • Income generation • The interval of compounding	
Unit3	**Introduction to optimization:**	**08 Lectures**
	• Profit maximization • Critical points • Profit maximization using derivatives	
Unit 4	**Portfolios**	**08 Lectures**
	• Introduction to portfolios • Making money with matrices • A two-industry 'economy', arbitrage portfolios and state prices	
	Total Lectures	**30 Lectures**

Reference Books:

1. Introduction to Financial Mathematics by Arash Fahim, Florida State University, 2019.
2. Mathematical Economics by Edward T. Dowling, Schaum's outline Series. McGraw Hill International Edition, Second Edition.
3. Calculus of Finance by Amber Habib, University Press, 2011.
4. Mathematics for Economics and Finance Methods and Modeling by Martin Anthony and Norman Biggs, Cambridge University Press, 2012

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU3501 **Course Name: Lab Course on Computer Oriented Numerical Methods**

Teaching Scheme: TH: 4 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisites:

- Equations, Functions, Polynomials and Differential Equations.

Course Objectives: To study

- Solution of equations
- Solution of the system of linear equations.
- Curve fitting.
- Polynomial approximation and interpolation.
- Numerical differentiation and integration.
- Solving Ordinary Differential Equations

- **Course Outcomes:** On completion of the course, student will be able to: -
  - Find approximate real root of an equation
  - Solve a system of linear equations numerically.
  - Approximate a function by a polynomial with desired accuracy.
  - Interpolate an equally spaced and unequally spaced data.
  - Find numerical differentiation and integration.
  - Solve Ordinary Differential Equations numerically.

Course Contents

Practical 1: Errors and Bisection method
Practical 2: Regula Falsi method and Secant method
Practical 3: Newton Raphson Method
Practical 4: Aitken's Δ^2-process.
Practical 5: Operators
Practical 6: Newton's forward interpolation formula
Practical 7: Newton's Backward interpolation formula
Practical 8: Lagrange's interpolation formula
Practical 9: Newton's Divided difference formula
Practical 10: Numerical Differentiation
Practical 11: Numerical Integration
Practical 12: Euler's Modified Method
Practical 13: Runge Kutta method
Practical 14: Gauss Seidel elimination method
Practical 15: Least square method

Reference Books:

1. Introductory Methods of Numerical Analysis by S.S. Sastry, Prentice Hall of India
   Fifth Edition, 2012.
2. Finite differences and Numerical Analysis by H.C. Saxena, S. Chand, 2010.
3. A textbook of Computer Based Numerical and Statistical Techniques by A. K.Jaiswal
   and Anju Khandelwal, New Age International Publishers, 2009.
4. Computer oriented Numerical Methods by V. Rajaraman, PHI Learning Private Limited,
   New Delhi, Third Edition, 2011.
5. Numerical Methods by E Balagurusamy, Tata McGraw Hill Education Private Limited, New Delhi, Reprint 2012.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4101 **Course Name: Linear Algebra**
Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 40 Marks **End-Sem : 60 Marks**

Prerequisites: Basic knowledge of function, matrices and system of linear equations.

Course Objectives: To study,

- How to find the dimension of a vector space.
- Inner product on a vector space.
- How to represent linear transformation as a matrix.

Course Outcomes: Student will be able to,

- Solve the problems on how to check whether a given set is a basis of a vector space.
- Understand the usual vector spaces used in analysis or other subjects.
- Understand use of Inner product spaces.

Course Contents :

Chapter 1	Vector Spaces	18 lectures

	• Definition and Examples, Subspaces, Necessary and Sufficient condition for subspace, Direct sum of subspaces. • Linear span, Linear dependence and independence. • Basis and dimension, Dimension of a subspace • Coordinates • Row space, Column space of a matrix • Null space, Range space, Dimension theorem for matrix, • Basis and dimension of solution space of homogeneous system of linear equations.	
Chapter 2	Linear Transformations	18 lectures
	• Definition and examples, Properties of linear transformation. • Composite of linear transformations, Equality of linear transformations. • Kernel and range of a linear transformation. • Inverse of a linear transformation. • Matrix of a linear transformation.	
Chapter 3	Eigen values and Eigen vectors	9 lectures

	• Eigen values and Eigen vectors of a matrix, Eigenspace. • Eigen values and Eigen vectors of a linear transformation. • Diagonalization of a matrix.	
Chapter 4	Inner product spaces	15 lectures
	• Inner product, Norm, Distance between two vectors. • Orthonormal basis, Orthogonal projection. • Gram Schmidt process to obtain orthonormal basis.	
	Total Lectures	**60 lectures**

Reference Books :

1. Schaum's outline of Theory and Problems of Linear Algebra by Seymour Lipschitz and Marc Lars Lipson, 3rd edition, 1968.
2. Introduction to Linear Algebra by Gilbert Strang, Wellesley-Cambridge Press,U.S.; 6th edition,2023.
3. Matrix and Linear Algebra aided with Matlab by Kanti Bhushan Datta, PHI Learning Pvt. Ltd., New Delhi, Second edition, 2012.
4. Linear Algebra, A geometric approach by S. Kumaresan, PHI Learning Pvt. Ltd., New Delhi, 2009.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4102 Course Name: Lab Course on 23ScMatU4101

(Section I)

Teaching Scheme: PR: 4 Hours/Week Credit: 02
Examination Scheme: CIA: 20 Marks End-Sem : 30 Marks

Prerequisite Course: Linear Algebra.
Course Objective: The student should be able to solve problems depending on the contents in
Linear Algebra.
Course Outcomes: On completion of the course, student will be able to

- Understand the theoretical concepts in Linear Algebra.
- Apply this knowledge in various courses of Science and Technology.

Course Contents

Practical 1 : Vector spaces

Practical 2 : Subspaces

Practical 3 : Sums and direct sums

Practical 4 : Linear dependence and independence

Practical 5 : Basis

Practical 6 : Row space and column space

Practical 7 : Applications to matrices

Practical 8 : Linear transformations

Practical 9 : Kernel and image

Practical 10 : Isomorphism

Practical 11 : Eigenvalues and eigenvectors

Practical 12 : Diagonalization

Practical 13 : Inner product spaces

Practical 14 : Orthogonality

Practical 15 : Gram-Schmidt process

Reference Books :

1. Schaum's outline of Theory and Problems of Linear Algebra by Seymour Lipschitz and Marc Lars Lipson, 3rd edition, 1968.
2. Introduction to Linear Algebra by Gilbert Strang, Wellesley-Cambridge Press,U.S.; 6th edition,2023.
3. Matrix and Linear Algebra aided with Matlab by Kanti Bhushan Datta, PHI Learning Pvt. Ltd., New Delhi, Second edition, 2012.
4. Linear Algebra, A geometric approach by S. Kumaresan, PHI Learning Pvt. Ltd., New Delhi, 2009.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4102 Course Name: Lab Course on Scilab

(Section - II)

Teaching Scheme: TH: 4 Hours/Week Credit: 02
Examination Scheme: CIA: 20 Marks End-Sem: 30 Marks

Course Objectives:

- To study the Scilab coding for matrix representation and operations on

matrices
- To study the coding for solving the system of linear equations in Scilab
- To study the process to evaluate eigenvalues and eigenvectors of matrices.
- To develop the programming in Sci-notes.
- To analyze the given data.

Course Outcomes: On completion of the course, student will be able to: -
- Deal with operations on matrices
- Solve linear system of linear equations in Scilab
- Evaluate eigenvalues and eigenvectors of matrix and also diagonalization of matrix
- Plot of two-dimensional and three-dimensional curves/surfaces.
- Solve equations using numerical methods.
- Perform data analysis

Course Contents

Practical 1: Introduction of Scilab
Practical 2: Scilab editor
Practical 3: Representation of Matrices
Practical 4: Operations on Matrices
Practical 5: System of linear equations
Practical 6: Eigenvalues and eigenvectors
Practical 7: Diagonalization of matrix
Practical 8: Graphs of functions of one variable
Practical 9: Graphs of functions of two variables
Practical 10: Numerical methods for finding roots of equations
Practical 11: Numerical interpolation
Practical 12: Numerical integration
Practical 13: Vectors
Practical 14: Frequency distribution
Practical 15: Probability distribution

Reference Books:

1. Scilab: A free software to MATLAB, by Achuthsankar S Nair, S, Chand and Company LTD. Company, 2012.
2. Introduction to Scilab: For Engineers and Scientists, by Sandeep Nagar, Apress, 2017.
3. Computing in Scilab, by Chetana Jain, Cambridge University Press, 2023.
4. https://www.ee.iitm.ac.in/~hsr/scilab/manual.pdf
5. https://www.scilab.org/sites/default/files/Scilab_beginners.pdf

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4301 **Course Name:**

Elementary Calculus

(Section - I)

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Semester: 30 Marks**

Prerequisites:

- Sets, Relation, Limits, Function, Continuity, Differentiability

Course Objectives:

To Study

- Relations and their types of relations.
- Functions and their types of functions.
- Continuity, derivative and their geometrical interpretations.
- Applications of mean value theorems and successive differentiation.
- Taylor's theorem, Maclaurin's theorems and their applications.

Course Outcomes:

On completion of the course, student will be able to:-

- Understand various properties of relations and functions.
- Understand concept and application of continuity, differentiability and mean value theorems.
- Find the nth derivative of the real valued function of a real variable.
- Expand various elementary functions in terms of power series.

Course Contents:

Chapter 1	**Relations and Functions**	9 lectures
	● Relations, Types of relations, Equivalence relations. Partial relations. ● Equivalence class, Properties and partition of a set. ● Digraphs of relations, matrix representation and composition of relations. ● Definition of a function as a relation, types of functions (one-one, onto and bijective). ● Transitive closure and Warshall's Algorithm.	
Chapter 2	**Continuity, Differentiability and Integration**	11 lectures
	● Limits. ● Continuity and properties of continuous functions. ● Differentiability and its properties. ● Left hand derivative and Right hand derivative. ● Intermediate value theorem. ● Rolle's mean value theorem. ● Lagrange's mean value theorem. ● Cauchy's mean value theorem. ● Fundamental theorem of Calculus	
Chapter 3	**Successive Differentiation**	5 lectures

	• The n^{th} derivatives of standard functions. • Leibnitz's theorem and applications. • L' Hopital's rule and it's application.	
Chapter 4	**Taylor's and Maclaurin's Theorems**	5 lectures
	• Taylor's Theorems with Lagrange's and Cauchy's form of remainders. • Maclaurin's Theorems with Lagrange's and Cauchy's form of remainders. • Taylor's and Maclaurin's Series.	
Total Lectures		**30**

Reference Books:

1. Mathematical Analysis by S. C. Malik and Savita Arora, New Age International Pvt. Ltd.
   (Second edition), 1992.
2. Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley &
   Sons (3^{rd} Edition), 2000
3. Calculus Volume I – One Variable Calculus with Introduction to Linear Algebra by Tom
   M. Apostol, John Wiley and Sons (2^{nd} Edition), 2002.
4. Differential Calculus by Shanti Narayan and Mittal P. K., S. Chand and Co. (11^{th} Edition), New Delhi, 2005.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4301 **Course Name: Elementary Calculus**

(Section -II)

Teaching Scheme: 4 Hours/ Week **Credit: 02**

Examination Scheme: CIA: 20 Marks **End-Semester: 30 Marks**

Prerequisites:

- Sets, Relation, Function, Limits, Continuity, Differentiability.

Course Objectives:

To Study

- Relations and their types of relations.
- Functions and their types of functions.
- Continuity, derivative and their geometrical interpretations.
- Applications of mean value theorems and successive differentiation.
- Taylor's theorem, Maclaurin's theorems and their applications.

Course Outcomes:

On completion of the course, student will be able to:-

- Understand various properties of relations and functions.
- Understand concept and application of continuity, differentiability and mean value theorems.
- Find nth derivative of real valued function.
- Expand elementary functions in terms of power series.

Course Contents:

Practical 1: Relations

Practical 2: Functions
Practical 3: Equivalence and partial order relations
Practical 4: Transitive closure and Warshall's algorithm
Practical 5: Limits and Continuity
Practical 6: Intermediate value theorem
Practical 7: Differentiability
Practical 8: Rolle's theorem
Practical 9: Lagrange's mean theorem
Practical 10: Cauchy's mean value theorem
Practical 11: L'Hopital's rule and its application
Practical 12: Successive differentiation
Practical 13: Leibnitz's theorem
Practical 14: Taylor's and Maclaurin series
Practical 15: Integration

Reference Books:

1. Mathematical Analysis by S. C. Malik and Savita Arora, New Age International Pvt. Ltd.
   (Second edition), 1992.
2. Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley &
   Sons (3rd Edition), 2000
3. Calculus Volume I – One Variable Calculus with Introduction to Linear Algebra by Tom
   M. Apostol, John Wiley and Sons (2nd Edition), 2002.
4. Differential Calculus by Shanti Narayan and Mittal P. K., S. Chand and Co. (11th Edition),
   New Delhi, 2005.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code:23ScMatU4401 **Course Name: Basics of Operations Research**
Teaching Scheme: TH: 2 Hours/Week
Credit: 02
Examination Scheme: CIA: 20 Marks
End-Sem: 30 Marks

Prerequisites: Basic knowledge of linear equations, linear inequality, graphs.

Course Objectives: The aim of this course is to study

- How to formulate real world problems into mathematical models.
- How to find optimum solution of real-world problems using various techniques of operations research.
- Scope and applications of operations research.
- How to build capabilities in the students for analyzing different situations in the industrial scenario involving limited resources and finding the optimal solution within constraints.

Course Outcomes: On completion of the course, student will able to

- Apply the concept of operations research in solving complex problems in economics, finance, defense and management science.
- Design the real-life problems which help in decision making.
- Find optimum solution of formulated linear programming problem.
- Construct various mathematical models in operations research.

Course Contents:

Unit 1	**Introduction to operations research**	**05 Lectures**

	• History of operations research • Objective of History of operations research • Applications of operations research • Types of mathematical models in operations research • Limitations of operations research	
Unit 2	**Linear programming problems**	**13 Lectures**
	• Formulation of linear programming problem • Advantages of linear programming problem • Solutions of linear programming problem using graphical method • Assignment problem • Solution of assignment problem	
Unit 3	**Game theory**	**12 Lectures**
	• Formulation of games • Two person-zero sum game • Games with and without saddle point • Graphical solution (2x n, m x 2 game)	
	Total Lectures	**30 Lectures**

Reference Books:

1. Operations Research (Techniques for Management) by V.K. Kapoor, S. Chand, fifth Edition, 2001.
2. Operations Research (Theory and Applications) by J.K. Sharma, Macmilan India Ltd., fifth Edition, 2013.
3. Operations Research (Theory, Methods & Applications) by S.D. Sharma, Kedarnath Ramnath & co, 1992.

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Second Year of B.Sc. Mathematics
(2023 Course under NEP 2020)

Course Code: 23ScMatU4601 **Course Name: Lab Course on Vector Calculus**
Teaching Scheme: TH: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisites: Basic knowledge of limits, continuity and derivative of one variable function, partial derivative, double and triple integral, curves and surfaces., Maxima software

Course Objectives: The aim of this course is to study

- The limit, continuity and derivative of vector valued functions of one, two and three variables.
- Line integral, surface integral and volume integral.

Course Outcomes: On completion of the course, student will able to understand

- Limits, continuity and gradient.
- Concept of gradient of scalar function, divergence and curl of vector function.
- Use of gradient, divergence, curl and applications of Green's theorem. Stokes theorem and Gauss Divergence theorem.
- Use of integration to find the area of a closed region, surface area and volume of surfaces.

Course Contents

Practical 1: Vector functions of one variable.
Practical 2: Limit of vector function
Practical 3: Continuity of vector function
Practical 4: Constant vector functions
Practical 5: Tangent planes and normal lines
Practical 6: Gradient of scalar function

Practical 7: Directional derivative
Practical 8: Divergence of a vector field
Practical 9: Curl of vector field
Practical 10: Solenoidal and conservative vector field
Practical 11: Integrals and fundamental theorem of calculus
Practical 12: Line integral
Practical 13: Green's theorem
Practical 14: Divergence theorem
Practical 15: Stokes' theorem

Reference Books:

1. J. N. Sharma, A. R. Vasishtha, Vector Calculus, Krishna Prakashan Media, Thirteenth Edition: 2004.
2. Thomas' Calculus, 11th Edition, G. B. Thomas. Revised by Maurice D. Weir, Joel Hass and Frank R. Giordano. Pearson Edition 2012.Articles: 13.1, 13.3, 13.4, 16.1 to 16.8.
3. T.M. Apostol, Calculus Vol. II (2nd Edition), John Wiley, New York, (1967).
4. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A. Weinstein, Springer Verlag (Indian Edition, 2009).
5. Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company, (1955).