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)

Choice Based Credit System (CBCS) Syllabus Under
National Education Policy (NEP)

To be implemented from Academic Year 2024-2025

Level:- 4.5 (First Year) **Sem:I**

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ (T/P) (2) or T(4)	24ScMatU1101	Algebra	2		2		20	30	50
	24ScMatU1102	Lab Course on 24ScMatU1101		2		4	20	30	50
Subject 2 T(2)+ (T/P) (2) or T(4)	24Sc***U1201	<<Subject 2 Theory>>	2		2		20	30	50
	24Sc***U1202	<<Subject 2 Practical>>		2		4	20	30	50
Subject 3 T(2)+ (T/P) (2) or T(4)	24Sc***U1301	<<Subject 3 Theory>>	2		2		20	30	50
	24Sc***U1302	<<Subject 3 Practical>>		2		4	20	30	50
IKS T(2)	24CpCopU1901	Generic IKS	2		2		20	30	50
GE/OE (T/P) (2)	24ScMatU1401	Fundamentals of Mathematics	2		2		20	30	50
SEC (P) (2)	24ScMatU1601	Lab Course on Analytical Geometry		2		4	20	30	50
AEC T(2)	24CpCopU1701 / 24CpCopU1702	MIL-I (Hindi) / MIL-I (Marathi)	2		2		20	30	50
VECT (2)	24CpCopU1801	Environmental Science	2		2		20	30	50
Total			14	08	14	16			550

Level:- 4.5 (First Year) **Sem:II**

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	ESE	Total
Subject 1 T(2)+ T/P(2) or T(4)	24ScMatU2101	Calculus	2		2		20	30	50
	24ScMatU2102	Lab Course on 24ScMatU2101		2		4	20	30	50
Subject 2 T(2)+ P(2)	24Sc***U2201	<<Subject 2 Theory>>	2		2		20	30	50
	24Sc***U2302	<<Subject 2 Practical>>		2		4	20	30	50
Subject 3 T(2)+ P(2)	24Sc***U2301	<<Subject 3 Theory>>	2		2		20	30	50
	24Sc***U2302	<<Subject 3 Practical>>		2		4	20	30	50
GE/OE (T/P)(2)	24ScMatU2401	Business Mathematics	2		2		20	30	50
SEC P(2)	24ScMatU2601	Lab course on Logic		2		4	20	30	50
AEC T(2)	24CpCopU2703	English Communication Skills I	2		2		20	30	50
VEC T(2)	24CpCopU2801	Democracy, Election and Governance	2		2		20	30	50
CC(2)	24CpCopU2001/ 24CpCopU2011 / 24CpCopU2021 / 24CpCopU2031 / 24CpCopU2041 / 24CpCopU2051 / 24CpCopU2061 / 24CpCopU2071	Physical Education / Cultural Activities / NSS / NCC / Fine Arts / Applied Arts / Visual Arts / Performing Arts	2		2		20	30	50
Total			14	08	14	16			550

Level:- 5.0 (Second Year) Sem:III

Course Type	**Course Code**	**Course Title**	**Credits**		**Teaching Scheme Hr/Week**		**Evaluation Scheme and Max Marks**		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMatU3101	Multivariate Calculus	4		4		40	60	100
	24ScMatU3102	Lab Course on 24ScMatU3101		2		4	20	30	50
VSC P(2)	24ScMatU3501	Lab Course on Discrete Mathematics		2		4	20	30	50
IKS (T/P)(2)	24ScMatU3901	Ancient Indian Mathematics	2		2		20	30	50
FP P(2)	24ScMatU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScMatU3301	Numerical Methods And Its Applications	2		2		20	30	50
	24ScMatU3302	Lab Course On 24ScMatU3301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMatU3401	Financial Mathematics	2		2		20	30	50
AEC T(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CC T(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			14	08	14	16			550

Level:- 5.0 (Second Year) Sem:IV

Course Type	**Course Code**	**Course Title**	**Credits**		**Teaching Scheme Hr/Week**		**Evaluation Scheme and Max Marks**		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2 or 4), (T/P)(2)	24ScMatU4101	Linear Algebra	4		4		40	60	100
	24ScMatU4102	Lab Course on 24ScMatU4101		2		4	20	30	50
VSC P(2)	24ScMatU4501	Lab Course on Computational Geometry		2		4	20	30	50
CEP P(2)	24ScCopU4003	Community Engagement Project		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScMatU4301	Linear Algebra	2		2		20	30	50
	24ScMatU4302	Lab Course on 24ScMatU4301		2		4	20	30	50
GE/OE (T/P) (2)	24ScMatU4401	Basics of Operations Research	2		2		20	30	50
SEC P(2)	24ScMatU4601	Lab Course on SciLab		2		4	20	30	50
AEC T(2)	24CpCopU4701 / 24CpCopU4702	MIL-II (Hindi) / MIL-II (Marathi)	2		2		20	30	50
CC T(2)	24CpCopU4001	Health and Wellness	2		2		20	30	50
Total			12	10	12	20			550

Level:- 5.5 (Third Year) **Sem:-V**

Course Type	**Course Code**	**Course Title**	**Credits**		**Teaching Scheme Hr/Week**		**Evaluation Scheme and Max Marks**		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4 + 2+2 or 4 + 4) P(2+2 or 4)	24ScMatU5101	Real Analysis	4		4		40	60	100
	24ScMatU5102	Abstract Algebra	4		4		40	60	100
	24ScMatU5103	Vector Calculus	2		2		20	30	50
	24ScMatU5104	Lab Course on 24ScMatU5101 & 24ScMatU5102		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScMatU5201	Operations Research	2		2		20	30	50
	24ScMatU5202	Lab Course on 24ScMatU5201		2		4	20	30	50
	24ScMatU5203	Metric Spaces	2		2		20	30	50
	24ScMatU5204	Lab Course on 24ScMatU5203		2		4	20	30	50
VSC P(2)	24ScMatU5501	Lab Course on Computer Oriented Numerical Methods		2		4	20	30	50
FP P(2)	24ScMatU5001	Field Project II		2		4	20	30	50
Minor (T/P) (2)	24ScMatU5302	Lab Course on Ordinary Differential Equations		2		4	20	30	50
Total			12	10	12	20			550

Level:- 5.5 (Third Year) **Sem:-VI**

Course Type	**Course Code**	**Course Title**	**Credits**		**Teaching Scheme Hr/Week**		**Evaluation Scheme and Max Marks**		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2+2+2 or 4+2+2 or 4+4) P(2+2 or 4)	24ScMatU6101	Complex Analysis	4		4		40	60	100
	24ScMatU6102	Differential Equations	4		4		40	60	100
	24ScMatU6103	Number Theory	2		2		20	30	50
	24ScMatU6104	Lab Course on 23ScMat6101 & 23ScMat6102		2		4	20	30	50
Major Elective (T/P) (2+2 or 4)	24ScMatU6201	Graph Theory	2		2		20	30	50
	24ScMatU6202	Lab Course on 24ScMatU6201		2		4	20	30	50
	24ScMatU6203	Laplace Transforms and Fourier Series	2		2		20	30	50
	24ScMatU6204	Lab Course on 24ScMatU6203		2		4	20	30	50
VSC P(2)	24ScMatU6501	Lab Course on Python		2		4	20	30	50
OJT P(2)	24ScMatU6004	On Job Training		4		8	40	60	100
Total			12	10	12	20			550

Level:- 5.0 (Second Year) Sem:III

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Second Year of B.Sc.
(2024 Course under NEP 2020)

Course Code : 24ScMatU3101 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	Limit and Continuity	10 lectures
	● Functions of several variables ● Graphs and level curves of functions. ● Limits and continuity.	
Chapter 2	Partial Derivatives	5 lectures
	● Partial derivatives ● Second order partial derivatives. ● Mixed derivative theorem. ● Partial derivatives of higher order.	
Chapter 3	Differentiability	15 lectures
	● Differentiability ● Conditions for differentiability. ● Increment theorem ● 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 ● First derivative test. ● Second derivative test ● Lagrange's multipliers method	
Chapter 5	Multiple Integrals	20 lectures
	● Double integral over rectangle ● Fubini's theorem ● 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. ● Spherical and cylindrical coordinates in triple integration. ● Applications to find area and volumes.	

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 (2nd Edition) John Wiley, New York (1967).

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Second Year of B.Sc.

(2024 Course under NEP 2020)

Course Code :24ScMatU3102 Course Name : Lab Course on 24ScMatU3101

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 : Limit

Practical 2 : Continuity

Practical 3 : Mixed partial derivative

Practical 4 : Partial derivative

Practical 5 : Differentiation

Practical 6 : Applications of differentials

Practical 7 : Euler's theorem

Practical 8 : Extreme values

Practical 9 : Applications of extreme values

Practical 10 : Lagrange's multipliers method

Practical 11 : Double integration

Practical 12 : Double integration using change of variables

Practical 13 : Change of order of integration

Practical 14 : Triple integration

Practical 15 : Application of integration

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.
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Course Code: 24ScMatU3501
Course Name: Lab Course on Discrete Mathematics
Teaching Scheme: PR: 4 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem : 30 Marks**

Prerequisite Courses: Basic knowledge of counting, permutations and combinations.

Course Objective: The aim of this course is to study
- Combinatorics
- Discrete structures such as posets, lattices, graphs, and trees

Course Outcomes: On completion of the course, students will be able to understand:
- The mathematical tools to solve combinatorial problems.
- Theory of discrete structures.
- Applications of combinatorics and discrete structures.

Course Contents:

Practical 1 : Mathematical induction and Pigeonhole principle
Practical 2 : Inclusion-Exclusion principle
Practical 3 : Arrangement and selection without repetition
Practical 4 : Arrangement and selection with repetition
Practical 5 : Distributions
Practical 6 : Recurrence relations
Practical 7 : Generating functions
Practical 8 : Posets
Practical 9 : Lattices
Practical 10: Graphs
Practical 11: Trees
Practical 12: Isomorphism
Practical 13: Colouring of graphs
Practical 14: Postman/Salesman problems
Practical 15: Shortest path algorithms

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 (6th Edition), 2009.

3. Applied Combinatorics by Alan Tucker, Wiley Publication, Fourth Edition 2001.
4. Graph Theory with Applications to Engineering and Computer Science by Deo, Narsingh. (1974).

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Second Year of B.Sc. Mathematics
(2024 Course under NEP 2020)

Course Code: 24ScMatU3901
Course Name: Ancient Indian Mathematics
Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Pre-requisites: Mathematics up to SSC level

Course Objectives: To study

- Numbers, fractions and geometry in the Vedas
- Decimal nomenclature of numbers in the Vedas
- Zero and Infinity
- Simple constructions from Sulba-sutras
- The development of the decimal place value system which resulted in a simplification of all arithmetical operations
- Linguistic representation of numbers
- Important texts of Indian mathematics
- Proofs in Indian Mathematics
- Brief introduction to the development of algebra, trigonometry and calculus
- Overview of development of Mathematics in India during the ancient and early classical Period (till 500 CE), later classical period (500-1250), medieval period (1250-1750) and modern periods (1750- present

Course Outcomes:

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

- Understand glorious history of Mathematics and valuable contribution by Indian mathematicians to the world

- To Research on the Indian Knowledge System.

Course Contents:

Unit 1	Mathematics in the Vedas and Śulva Sūtras	2 Hours
Unit 2	Pāṇini's *Aṣṭādhyāyī*	1 Hours
Unit 3	Piṅgala's *Chandaḥśāstra*	1 Hours
Unit 4	Mathematics in the Jaina Texts	1 Hours
Unit 5	Development of Place Value System	1 Hours
Unit 6	*Āryabhaṭīya* of Āryabhaṭa	2 Hours
Unit 7	*Brāhmasphuṭasiddhānta* of Brahmagupta	2 Hours
Unit 8	Bakṣālī Manuscript	1 Hours
Unit 9	*Gaṇitasārasaṅgraha* of Mahāvīra	1 Hours
Unit 10	Development of Combinatorics	2 Hours
Unit 11	*Līlāvatī* of Bhāskarācārya	2 Hours
Unit 12	*Bījagaṇita* of Bhāskarācārya	2 Hours
Unit 13	*Gaṇitakaumudī* of Nārāyaṇa Paṇḍita	2 Hours
Unit 14	Magic Squares	1 Hours
Unit 15	Kerala School of Astronomy and Development of Calculus	3 Hours
Unit 16	Trigonometry and Spherical Trigonometry	2 Hours
Unit 17	Proofs in Indian Mathematics	2 Hours
Unit 18	Mathematics in Modern India	2 Hours
	Total No. of Hours	**30**

Reference Books:

1. B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Parts, Lahore, 1935, 1938; Reprint, Asia Publishing House, Bombay 1962; Reprint, Bharatiya Kala Prakashan, Delhi 2004.
2. C. N. Srinivasa Nagar, History of Indian Mathematics, The World Press, Calcutta, 1967.
3. T. A. Saraswati Amma, Geometry in Ancient and Medieval India, Motilal Banarsidass, Varanasi, 1979.
4. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, 3rd Ed. Bhavan's Gandhi Centre, Bangalore, 2004.
5. G. G. Emch, M. D. Srinivas and R. Sridharan, Eds., Contributions to the History of

Mathematics in India, Hindustan Book Agency, Delhi, 2005.
6. C. S. Seshadri, Ed., Studies in History of Indian Mathematics, Hindustan Book Agency, Delhi, 2010.
7. P. P. Divakaran, The Mathematics of India Concepts Methods Connections, Hindustan Book Agency 2018. Rep Springer New York, 2018.
8.Gaṇitayuktibhāṣā (c.1530) of Jyeṣṭhadeva (in Malayalam), Ed. with Tr. by K. V. Sarma with Explanatory Notes by K. Ramasubramanian, M. D. Srinivas and M. S. Sriram, 2 Volumes, Hindustan Book Agency, Delhi, 2008.

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Course Code: 24ScMatU3301

Course Name: Numerical Methods And Its Applications

Teaching Scheme: TH: 2 Hours/Week **Credits: 2**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Prerequisites: Equations, Functions, Polynomials and Differential Equations.

Course Objectives: To Study

- Methods for solution of algebraic and transcendental equations, and a system of linear equations.
- Curve fitting using a line, a parabola, a power function and an exponential function.
- Polynomial approximation and interpolation.
- Numerical differentiation and integration.
- Numerical methods to solve Ordinary Differential Equation of first degree and first order.

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

- Find the approximate real root of the equation and solve a system of linear equations numerically.
- Approximate a known or unknown function by a polynomial with desired accuracy.
- Find numerical differentiation and evaluate definite integrals numerically.
- Solve first order and first degree Ordinary Differential Equations.

Course Contents:

Unit 1	Solutions of Equations	06 lectures
	• Bisection method. • Regula falsi method. • Newton-Raphson method.	
Unit 2	Interpolation	10 lectures
	• Operators Δ, ∇, E and their relations • Differences: forward, backward, divided • Fundamental theorem of difference calculus • Newton-Gregory formula for forward/backward interpolation. • Lagrange's interpolation formula.	
Unit 3	Integration	08 lectures
	• General quadrature formula. • Trapezoidal rule. • Simpson's 1/3rd rule. • Simpson's 3/8th rule.	
Unit 4	Applications	06 lectures
	• Euler's method. • Euler's modified methods • Largest eigenvalue using power 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. Linear Algebra and Its Applications by David C. Lay, Steven R. Lay, Judi J. McDonald, Sixth Edition, 2022.

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Second Year of B.Sc.
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Course Code: 24ScMatU3302
Course Name: Lab Course on 24ScMat3301
Teaching Scheme: PR: 4 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem : 30 Marks**

Prerequisites: Equations, Functions, Polynomials and Differential Equations.

Course Objective: 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, students 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: Curve fitting
Practical 2: Secant method
Practical 3: Newton Raphson Method
Practical 4: Iteration Method
Practical 5: Operators and their relations
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: Trapezoidal and Simpson's 1/3rd rule
Practical 12: Simpson's 3/8th rule
Practical 13: Euler modified method
Practical 14: Runge Kutta methods
Practical 15: Gauss Seidel 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.
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Course Code: 24ScMatU3401

Course Name: Financial Mathematics

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

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 modelling 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.
- Construct a model of the market.
- Determine supply and demand functions.
- Find and classify critical points.
- Solve profit maximization using derivatives.
- 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	
Unit 3	**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 Modelling by Martin Anthony and Norman Biggs, Cambridge University Press, 2012

Level:- 5.0 (Second Year) Sem:IV

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Second Year of B.Sc.
(2024 Course under NEP 2020)

Course Code: 24ScMatU4101
Course Name: Linear Algebra
Teaching Scheme: TH: 4 Hours/Week **Credits: 4**
Examination Scheme: CIA: 40 Marks **End-Sem : 60 Marks**

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

Course Objectives: To study,

- Basics of group theory.
- The dimension of a vector space.
- Inner product on a vector space.
- Matrix representation of a linear transformation.

Course Outcomes: Student will be able to,

- Understand algebraic structures.
- Check whether a given set is a basis of a vector space.
- Understand the usual vector spaces.
- Understand use of inner product spaces.

Course Contents :

Chapter 1	Vector Spaces	20 lectures
	• Simple algebraic structures • Vector space • Subspace. • Linear span, Linear dependence and independence. • Basis and dimension. • Row space and Column space of a matrix • Basis and dimension of solution space of homogeneous systems of linear equations.	
Chapter 2	Linear Transformations	15 lectures
	• Linear Transformations • Properties of linear transformation. • Matrix of a linear transformation. • Kernel and range of a linear transformation. • Rank Nullity theorem	
Chapter 3	Inner product spaces	15 lectures
	• Inner product, Norm, Angle and Distance between two vectors. • Parallelogram Law and Pythagorean Law in inner product spaces. • Orthogonal projection and Orthogonal basis. • Orthonormal basis • Gram Schmidt process to obtain orthonormal basis.	
Chapter 4	Eigenvalues and Eigenvectors	10 lectures
	• Eigenvalues and Eigenvectors of a linear transformation. • Diagonalization of a matrix.	
	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.
5. Linear Algebra and its Applications by David C. Lay, Steven Lay, Judy McDonald Sixth Edition, 2022.
6. Elementary Linear Algebra by Howard Anton and Chris Rorres, Wiley Publications, 2014.

Progressive Education Society's
Modern College of Arts, Science and Commerce(Autonomous),
Shivajinagar, Pune - 5
Second Year of B.Sc.
(2024 Course under NEP 2020)

Course Code: 24ScMatU4102
Course Name: Lab Course on 24ScMatU4101
Teaching Scheme: PR: 4 Hours/Week **Credit: 2**
Examination Scheme: CIA: 20 Marks **End-Sem : 30 Marks**

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

Course Objectives: To study,

- Basics of group theory.
- The dimension of a vector space.
- Inner product on a vector space.
- Matrix representation of a linear transformation.

Course Outcomes: Student will be able to,

- Understand algebraic structures.
- Check whether a given set is a basis of a vector space.
- Understand the usual vector spaces.
- Understand use of inner product spaces.

Course Contents:

Practical 1 : Vector spaces
Practical 2 : Subspaces
Practical 3 : Linear dependence and independence
Practical 4 : Basis
Practical 5 : Row space and column space
Practical 6 : Linear transformations
Practical 7 : Kernel and image
Practical 8 : Eigenvalues and eigenvectors
Practical 9 : Diagonalization
Practical 10 : Cayley Hamilton theorem
Practical 11 : Inner product spaces
Practical 12 : Geometry in Inner Product spaces
Practical 13 : Orthogonal projections
Practical 14 : Gram-Schmidt process

Practical 15 : LU decomposition

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.
5. Linear Algebra and its Applications by David C. Lay, Steven Lay, Judy McDonald Sixth Edition, 2022.
6. Elementary Linear Algebra by Howard Anton and Chris Rorres, Wiley Publications, 2014.

Progressive Education Society's
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Second Year B.Sc.
(2024 Course under NEP 2020)

Course Code: 24ScMatU4501
Course Name: Lab Course on Computational Geometry

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

Prerequisites: Matrix operations, planar graphs.

Course Objectives:

1) Students will learn about basic two-dimensional transformations such as translation, rotation, scaling, and reflection.
2) Students will study transformations in three-dimensional space, including rotation, scaling, translation, and shearing.
3) Students will learn about different types of projections, such as orthographic and perspective projections.
4) Students will study the mathematical foundations and algorithms used to generate plane curves, such as circle, ellipse, parabola, and hyperbola.
5) Students will explore the interconnections between transformations, projections, and curve generation.

Course Outcomes: On completion of the course

1) Students will be able to effectively apply translation, scaling, rotation, and reflection transformations to 2D geometric shapes and objects.
2) Students will be able to visualize the effects of 3D transformations in a computational environment.
3) Students will demonstrate the ability to apply different projection techniques such as orthographic and perspective projections to map 3D objects onto 2D planes.
4) Students will understand the mathematical foundations and applications of planar curves in fields like animation, CAD, and graphic design.
5) Students will develop algorithms to perform geometric operations, including transformations of curves and surfaces, and apply them to real-world applications like object rendering and modeling.
6) Students will demonstrate the ability to apply computational geometry techniques to real-world computer graphics, 3D rendering, virtual environment creation, modelling and simulation.

Course Contents

Practical 1: Two dimensional transformations
Practical 2: Transformation of polygons
Practical 3: Combined transformations
Practical 4: Area of a plane figure and solid body transformations
Practical 5: Homogeneous coordinates and translation
Practical 6: Rotation about arbitrary point
Practical 7: Reflection through arbitrary line
Practical 8: Three dimensional transformations
Practical 9: Reflection through a local axis
Practical 10: Reflection through planes parallel to coordinate planes
Practical 11: Orthographic and axonometric projections
Practical 12: Oblique projections
Practical 13: Perspective projections
Practical 14: Generation of points on a circle and an ellipse
Practical 15:Generation of an arc of parabola and hyperbola

Reference Books:

1) D.F.Rogers, J. A. Adam, Mathematical elements for computer graphics, Tata Mc Graw Hill International Edition, Second edition, 2002.
2) Donald Hearn and M Pauline Baker, Warren Carithers, Computer Graphics with Open GL, Pearson (4th edition), 2014.
3) Schaum's Outline Series, Computer Graphics, tata Mc Graw Hill International Edition, 2015.

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Second Year of B.Sc. Mathematics
(2024 Course under NEP 2020)

Course Code: 24ScMatU4301 **Course Name: Linear Algebra**

(Section - I)

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

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

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

Course Objectives: To study,

- The dimension of a vector space.
- Inner product on a vector space.
- Matrix representation of a linear transformation.

Course Outcomes: Student will be able to,

- Check whether a given set is a basis of a vector space.
- Understand the usual vector spaces.
- Understand use of inner product spaces.

Course Contents :

Chapter 1	Vector Spaces	10 lectures
	• Definition and Examples, Subspaces. • Linear span, Linear dependence and independence. • Basis and dimension. • Basis and dimension of solution space of homogeneous systems of linear equations.	
Chapter 2	Linear Transformations	10 lectures
	• Definition and examples, Properties of linear transformation. • Matrix of a linear transformation. • Kernel and range of a linear transformation. • Eigenvalues and Eigenvectors of a linear transformation.	
Chapter 3	Inner product spaces	10 lectures
	• Inner product, Norm, Distance between two vectors. • Parallelogram Law and Pythagorean Law in inner product spaces. • Orthogonal and Orthogonal sets.	
Total Lectures		**30 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.
5. Linear Algebra and its Applications by David C. Lay, Steven Lay, Judy McDonald Sixth Edition, 2022.
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(2024 Course under NEP 2020)

Course Code: 24ScMatU4302 **Course Name: Lab Course on 24ScMatU4301 (Section -II)**

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

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

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

Course Objectives: To study,

- The dimension of a vector space.
- Inner product on a vector space.
- Matrix representation of a linear transformation.

Course Outcomes: Student will be able to,

- Check whether a given set is a basis of a vector space.
- Understand the usual vector spaces.
- Understand use of inner product spaces.

Course Contents :

Practical 1 : Vector spaces

Practical 2 : Subspaces

Practical 3 : Linear dependence and independence

Practical 4 : Basis

Practical 5 : Row space and column space

Practical 6 : Linear transformations

Practical 7 : Kernel and image

Practical 8 : Eigenvalues and eigenvectors of 2 x 2 matrix

Practical 9 : Eigenvalues and eigenvectors of 3 x 3 matrix

Practical 10 : Diagonalization

Practical 11 : Cayley Hamilton theorem

Practical 12 : Inner product spaces

Practical 13 : Orthogonal and Orthonormal sets

Practical 14 : Gram-Schmidt process in R^2

Practical 15 : Gram-Schmidt process in R^3

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.
5. Linear Algebra and its Applications by David C. Lay, Steven Lay, Judy McDonald Sixth Edition, 2022.
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Second Year of B.Sc.

(2024 Course under NEP 2020)

Course Code: 24ScMatU4401

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 analysing 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.
- Solve assignment problems.
- Formulate and solve two-person zero sum games.
- 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

(2024 Course under NEP 2020)

Course Code: 24ScMatU4601

Course Name: Lab Course on Scilab

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

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

Course Objectives: To study Scilab to

- Find greatest common divisor and least common multiple of given two integers
- Define a polynomial and find its roots
- Represent the Matrix and perform operations on matrices
- Solve the system of linear equations
- Evaluate eigenvalues and eigenvectors of matrices.
- Draw the graphs of functions
- Write a program for numerical methods.
- Study special functions.
- Solve problems of Differential Calculus

Course Outcomes: On completion of the course, Using Scilab, student will be able to: -

- Find GCD and LCM of given two integers
- Define a polynomial and find its roots
- Declare the matrices and perform operations on them
- Solve system of linear equations in Scilab
- Find eigenvalues and eigenvectors of matrix
- Plot graph for one variable and two variables functions.
- Write a program for numerical methods
- Solve problems of Differential Calculus

Course Contents:

	List of Practicals	**60 Hours**
Practical 1	Introduction of Scilab	
Practical 2	GCD, LCM and Primes	
Practical 3	Trigonometry	
Practical 4	Polynomials	
Practical 5	Representation of Matrices	
Practical 6	Operations on Matrices	
Practical 7	System of linear equations	
Practical 8	Eigenvalues and eigenvectors	
Practical 9	Graphs of functions of one variable	
Practical 10	Graphs of functions of two variables	
Practical 11	Numerical methods for finding roots of equations	
Practical 12	Numerical interpolation	
Practical 13	Numerical integration	
Practical 14	Special Functions	
Practical 15	Differential Calculus	

Reference Books:

1. Modeling and Simulations in Scilab/Scicos by Stephen Campbell, Jean Philippe Chancellor, Ramine Nikoukhah, Springer, 2006.
2. Scilab: A free software to MATLAB, by Achuthsankar S Nair, S, Chand and Company LTD. Company, 2012.
3. Introduction to Scilab: For Engineers and Scientists, by Sandeep Nagar, Apress, 2017.
4. Computing in Scilab, by Chetana Jain, Cambridge University Press, 2023.
5. https://www.ee.iitm.ac.in/~hsr/scilab/manual.pdf
6. https://www.scilab.org/sites/default/files/Scilab_beginners.pdf