Estd. 1962
NAAC 'A' Grade

SHIVAJI UNIVERISTY, KOLHAPUR-416 004. MAHARASHTRA
PHONE : EPABX-2609000 website- www.unishivaji.ac.in
FAX 0091-0231-2691533 & 0091-0231-2692333 – BOS - 2609094
शिवाजी विद्यापीठ, कोल्हापूर – 416004.
दुरध्वनी (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग– २६०९०९४)
फॅक्स : ००९१-०२३१-२६९१५३३ व २६९२३३३.e-mail:bos@unishivaji.ac.in

SU/BOS/Science & Technology /864 **Date: 20/12/2023**

To,

The Principal, **All affiliated colleges,** **Shivaji University, Kolhapur.**	**The Head,** **Department of Mathematics,** **Shivaji University, Kolhapur**

Subject:Regarding minor changes in the syllabi of M.Sc.Part-I (Mathematics) Sem-I & II under the Faculty of Science & Technology.

Sir/Madam,

With reference to the subject mentioned here above, I am directed to inform you that the university authorities have accepted and granted approval to the minor changes in the syllabi of **Research Methodology-I and Lattice Theory-II.** of M.Sc.Part-I (Mathematics) Sem- I & II under the Faculty of Science & Technology.

This minor change in said Syllabus of will be implemented from the academic year 2024-25.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Copy to :-

1	The Dean, Faculty of Science & Technology	8	Appointment Section
2	The Chairman, Respective, BOS	9	Centre for Distance Education
3	Exam Section	10	Computer Centre
4	Eligibility Section	11	Affiliation Section (U.G.)
5	O.E. I Section	12	Affiliation Section (P.G.)
6	O.E. II Section	13	P.G.Admission Section
7	O.E. III Section	14	P.G.Seminar Section

SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
PHONE:EPABX–2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर - ४१६००४, महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी विभाग ०२३१–२६०९०९४

Estd. 1962
"A++" Accredited by
NAAC(2021)
With CGPA 3.52

जा.क्र.शिवाजी वि./अमं/732 दिनांक. 09/10/ 2023

प्रति,

मा. अध्यक्ष व सदस्य,
सर्व अभ्यास/अस्थायी मंडळे (सायन्स)
शिवाजी विद्यापीठ, कोल्हापूर

विषय :– शैक्षणिक वर्षे 2023–24 पासून एम.एस्सी. अभ्यासक्रमाच्या आराखडया (Structure) बाबत.

महोदय/महोदया,

उपरोक्त विषयास अनुसरून आदेशान्वये कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण, 2020 ची राज्यातील अंमलबजावणीच्या अनुषंगाने विद्यापीठ अधिकार मंडळाच्या निर्णयानुसार शैक्षणिक वर्षे 2023–24 पासुन एम.एस्सी. अभ्यासक्रमासाठी सोबत जोडलेला कॉमन आराखडा **(Structure)** व **Formatting (Templet)** लागू करण्यात आले आहे याची नोंद घ्यावी.

सदरची बाब सर्व शिक्षक, विद्यार्थी व संबंधीतांच्या निदर्शनास आणावी.

कळावे,

आपला विश्वासू

(डॉ. एस. एम. कुबल)
उपकुलसचिव

प्रतः–

प्र.अधिष्ठाता विज्ञान व तंत्रज्ञान विद्याशाखा
मा.संचालक परीक्षा व मुल्यमापन मंडळ
परीक्षक नियुक्ती विभाग–1,2
सर्व परीक्षा विभाग (ऑन)
माहितीसाठी व पुढील योग्य त्या कार्यवाहीसाठी.

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SHIVAJI UNIVERSITY, KOLHAPUR - 416 004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर - ४१६ ००४,महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९३/९४

SU/BOS/Science/482 **Date: 01/07/2023**

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.

Subject: Regarding syllabi of M.Sc. Part-I (Sem. I & II) as per NEP-2020 degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-I (Sem. I & II) as per NEP-2020 degree programme under the Faculty of Science and Technology.

M.Sc. Part I (Sem I & II) as per NEP-2020			
1.	Mathematics	5.	Botany
2.	Mathematics (Distance Mode)	6.	Statistics
3.	Mathematics (Online Mode)	7.	Applied Statistics and Informatics
4.	Zoology		

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in**)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science (Mathematics)

under
Faculty of Science and Technology

(To Be Implemented From Academic Year 2023-24)

INDEX

1. Preamble

The Department of Mathematics was established in the year 1964. Since then it has been consistently endeavoring to strengthen the academic foundations by exploring new areas of higher learning and research. Well qualified faculty, specialized in various disciplines is the strength of the Department. Faculty members are actively engaged in the teaching, research and extension activities. The department has its own library with around 6000 books funded by the NBHM, well equipped computer lab with internet facilities and the well-furnished Ramanujan hall having hundred seating capacity.

2. Duration:

The M.Sc. (Mathematics) will be a full-time TWO years (4 semesters) programme.

3. Eligibility for Admission:

Eligibility for level 6:

i) Any candidate who has successfully completed B. Sc. with a principal subject Mathematics or with a subsidiary subject Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

OR

ii) Any candidate who has successfully completed the Bachelor's degree with Mathematics courses at Second Year of Bachelor's degree of this University or of any other statutory University recognized by UGC, New Delhi.

OR

iii) Any candidate who has successfully completed level 5.5 with major or minor subject as Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

Eligibility for level 6.5:

i) Any candidate who has successfully completed Post Graduate Diploma (Level 6.0) in Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

OR

ii) Any candidate who has successfully completed Bachelor's Degree (Honours / Honours with Research) (Level 6.0) with principal / major subject Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

OR

iii) Completed all requirements of the relevant Post Graduate Diploma (Level 6.0) in Mathematics.

4. Medium of Instruction:

The medium of Instruction will be English.

5. Programme Structure

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Mathematics) Part – I (Level-6.0)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures + Tutorial/ (Hours / week)	Practical (Hours / week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-I										
Major Mandatory	MMT-101	4+1	--	4	80	32	3	20	8	1
	MMT -102	4+1	--	4	80	32	3	20	8	1
	MMT-103	4+1	--	4	80	32	3	20	8	1
	MMT -104	2+1	--	2	40	16	2	10	4	1/2
Major Elective	MET-105	4+1	--	4	80	32	3	20	8	1
Research Methodology	RM-106	4+1	--	4	80	32	3	20	8	1
Total				22	440			110		
Semester-II										
Major Mandatory	MMT-201	4+1	--	4	80	32	3	20	8	1
	MMT -202	4+1	--	4	80	32	3	20	8	1
	MMT -203	4+1	--	4	80	32	3	20	8	1
	MMT -204	2+1	--	2	40	16	2	10	4	1/2
Major Elective	MET-205	4+1	--	4	80	32	3	20	8	1
OJT/FP	OJT-206	--	8	4	80	32	3	20	8	1
Total				22	440			110		
Total (Sem I + Sem II)				44						

• MMT – Major Mandatory Theory • MMPR – Major Mandatory Practical • MET – Major Elective Theory • MEPR – Major Elective Practical • RM - Research Methodology • OJT/FP- On Job Training/ Field Project • S/T/PSS – Seminar/Tutorial/Problem Solving Session	• Total Marks for M.Sc.-I : **1100** • Total Credits for M.Sc.-I (Semester I & II) : 44 • ***Separate passing is mandatory for University and Internal Examinations*** • **Seminar/Tutorial/Problem Solving Session shall be taken batch wise. Each batch shall be of not more than 15 students.**

*Evaluation scheme for OJT/FP shall be decided by concerned BOS

- **Requirement for Entry at Level 6.0:**

1. Any candidate who has successfully completed B. Sc. with a principal subject Mathematics or with a subsidiary subject Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

OR

2. Any candidate who has successfully completed the Bachelor's degree with Mathematics courses at Second Year of Bachelor's degree of this University or of any other statutory University recognized by UGC, New Delhi.

OR

3. Any candidate who has successfully completed level 5.5 with major or minor subject as Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.

- **Requirement for Exit after Level 6.0:**
  Students can exit after completion of Level 6.0 with Post Graduate Diploma in Mathematics

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Mathematics) Part – II (Level-6.5)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures + Tutorial/ (Hours / week)	Practical (Hours / week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-III										
Major Mandatory	MMT-301	4+1	--	4	80	32	3	20	8	1
	MMT -302	4+1	--	4	80	32	3	20	8	1
	MMT -303	4+1	--	4	80	32	3	20	8	1
	MMT-304	2+1	--	2	40	16	2	10	4	1/2
Major Elective	MET-305	4+1	--	4	80	32	3	20	8	1
Research Project	RP-307	--	8	4	80	32	3	20	8	1
Total				22	440			110		
Semester-IV										
Major Mandatory	MMT-401	4+1	--	4	80	32	3	20	8	1
	MMT -402	4+1	--	4	80	32	3	20	8	1
	MMT -403	4+1	--	4	80	32	3	20	8	1
Major Elective	MET -405	4+1	--	4	80	32	3	20	8	1
Research Project	RP -407	--	12	6	100	40	3	50	20	2
Total				22	420			130		
Total (Sem III + Sem IV)				44						

<table>
<tr><td>• MMT – Major Mandatory Theory
• MMPR – Major Mandatory Practical
• MET – Major Elective Theory
• MEPR – Major Elective Practical
• RP- Research Project
• S/T/PSS – Seminar/Tutorial/Problem Solving Session</td><td>• Total Marks for M.Sc.-II : 1100
• Total Credits for M.Sc.-II (Semester III & IV) : 44
• Separate passing is mandatory for University and Internal Examinations
• Seminar/Tutorial/Problem Solving Session shall be taken batch wise. Each batch shall be of not more than 15 students.</td></tr>
<tr><td colspan="2">Evaluation scheme for Research Project: 80% weightage for University assessment and 20% for Internal Assessment.</td></tr>
<tr><td colspan="2">• Requirement for Entry at Level 6.5:
1. Any candidate who has successfully completed Post Graduate Diploma (Level 6.0) in Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.
OR
2. Any candidate who has successfully completed Bachelor’s Degree (Honours / Honours with Research) (Level 6.0) with principal / major subject Mathematics of this University or of any other statutory University recognized by UGC, New Delhi.
OR
3. Completed all requirements of the relevant Post Graduate Diploma (Level 6.0) in Mathematics.</td></tr>
<tr><td colspan="2">• Requirement for Exit after Level 6.5:
Students can exit after completion of Level 6.5 with Post Graduate in Mathematics.</td></tr>
</table>

6. Programme Outcomes (POs)

- To develop problem-solving skills and apply them independently to problems in pure and applied mathematics.
- To develop abstract mathematical thinking.
- To improve the abilities of students this will be helpful to qualify competitive examinations.
- Apply knowledge of Mathematics, in all the fields of learning including higher research.
- Work effectively as an individual, and also as a member or leader in multi-linguistic and multi-disciplinary teams.
- To qualify lectureship and fellowship exams such as NET, GATE, SET etc.
- Understand the basic concepts, fundamental principles and mathematical theories related to various courses and their relevance to other sciences.

7. Course Codes

M. Sc. (Mathematics) Part I (Semester I and II)

Semester	Code	Course Code	Title of New Course
I	MMT-101	MSU0325MML825G1	Linear Algebra
I	MMT-102	MSU0325MML825G2	Real Analysis
I	MMT-103	MSU0325MML825G3	Ordinary Differential Equations
I	MMT-104	MSU0325MML825G4	Numerical Analysis-I
I	MET-105	MSU0325MEL825G1	Combinatorics
		MSU0325MEL825G2	Differential Geometry
		MSU0325MEL825G3	Integral Transforms
		MSU0325MEL825G4	Theory of computations
		MSU0325MEL825G5	Graph Theory- I
		MSU0325MEL825G6	Lattice Theory-I
		MSU0325MEL825G7	Linear programming and its applications
		MSU0325MEL825G8	Dynamical Systems-I
		MSU0325MEL825G9	Basics of Python
		MSU0325MEL825G10	Web Technology
I	RM-106	MSU0325RML825G	Research Methodology
II	MMT-201	MSU0325MML825H1	Algebra
II	MMT-202	MSU0325MML825H2	Topology
II	MMT-203	MSU0325MML825H3	Advanced Calculus
II	MMT-204	MSU0325MML825H4	Numerical Analysis - II
II	MET-205	MSU0325MEL825H1	Number Theory
		MSU0325MEL825H2	Advanced Algebra
		MSU0325MEL825H3	Difference Equations
		MSU0325MEL825H4	Algebraic Automata Theory
		MSU0325MEL825H5	Graph Theory II
		MSU0325MEL825H6	Lattice Theory- II
		MSU0325MEL825H7	Quantitative techniques in operations Research
		MSU0325MEL825H8	Dynamical Systems-II
		MSU0325MEL825H9	Data Science with Python
		MSU0325MEL825H10	PHP with MySQL
II	OJT-206 / FP-206	MSU0325OJP825H / MSU0325FPP825H	On job Training / Field project

M. Sc.(Mathematics) Part II (Semester III and IV)

Semester	Code	Course Code	Title of New Course
III	MMT-301	MSU0325MML925I1	Functional Analysis
III	MMT-302	MSU0325MML925I2	Complex Analysis
III	MMT-303	MSU0325MML925I3	Classical Mechanics
III	MMT-304	MSU0325MML925I4	Advanced Discrete Mathematics
III	MET-305	MSU0325MEL925I1	Algebraic Number Theory
		MSU0325MEL925I2	Fluid Dynamics
		MSU0325MEL925I3	Dynamic Equations on Time Scales
		MSU0325MEL925I4	Coding Theory
		MSU0325MEL925I5	Fixed Point Theory
		MSU0325MEL925I6	Measure and Integration
		MSU0325MEL925I7	Introduction to Cryptography
		MSU0325MEL925I8	Automata, Languages And computations
		MSU0325MEL925I9	Fuzzy Mathematics - I
		MSU0325MEL925I10	Commutative Algebra-I
		MSU0325MEL925I11	Machine Learning
		MSU0325MEL925I12	React JS
III	RP-306	MSU0325RPP925I	Research Project
IV	MMT-401	MSU0325MML925J1	Integral Equations
IV	MMT-402	MSU0325MML925J2	Field Theory
IV	MMT-403	MSU0325MML925J3	Partial Differential Equations
IV	MET-404	MSU0325MEL925J1	Space Dynamics
		MSU0325MEL925J2	Computational Fluid Dynamics
		MSU0325MEL925J3	Fractional Calculus
		MSU0325MEL925J4	Approximation Theory
		MSU0325MEL925J5	Wavelet Analysis
		MSU0325MEL925J6	Boundary Value Problem
		MSU0325MEL925J7	Probability and Stochastic Processes
		MSU0325MEL925J8	Theory of Distribution
		MSU0325MEL925J9	Fuzzy Mathematics-II
		MSU0325MEL925J10	Commutative Algebra-II
		MSU0325MEL925J11	Deep Learning
		MSU0325MEL925J12	Cloud Computing
IV	RP-405	MSU0325RPP925J	Research Project

M.Sc. (Mathematics) Part–I (Level-6.0)

Semester	**Mandatory Major** 4 credits	**Mandatory Major** 2 credits	**Mandatory Elective (any one)** 4 credits	**Mandatory RM and OJT/FP** 4 credits
I	1) Linear Algebra 2) Real Analysis 3) Ordinary Differential Equations	Numerical Analysis-I	1) Combinatorics 2) Differential Geometry 3) Integral Transforms 4) Theory of computations 5) Graph Theory- I 6) Lattice Theory-I 7) Linear programming and its applications 8) Dynamical Systems-I 9) Basics of Python 10)Web Technology	Research Methodology
II	1) Algebra 2) Topology 3) Advanced Calculus	Numerical Analysis - II	1) Number Theory 2) Advanced Algebra 3) Difference Equations 4) Algebraic Automata Theory 5) Graph Theory II 6) Lattice Theory- II 7) Quantitative techniques in operations Research 8) Dynamical Systems-II 9) Data Science with Python 10)PHP with MySQL	On job Training/ Field project

M.Sc. (Mathematics) Part–II (Level-6.5)

Semester	**Mandatory Major** 4 credits	**Mandatory Major** 2 credits	**Mandatory Elective (any one)** 4 credits	**Mandatory RM and OJT/FP**
III	1) Functional Analysis 2) Complex Analysis 3) Classical Mechanics	Advanced Discrete Mathematics	1) Algebraic Number Theory 2) Fluid Dynamics 3) Dynamic Equations on Time Scales 4) Coding Theory 5) Fixed Point Theory 6) Measure and Integration 7) Introduction to Cryptography 8) Automata, Languages And computations 9) Fuzzy Mathematics - I 10) Commutative Algebra-I 11) Machine Learning 12) React JS	Research Project (4 credits)
IV	1) Integral Equations 2) Field Theory 3) Partial Differential Equations	---	1) Space Dynamics 2) Computational Fluid Dynamics 3) Fractional Calculus 4) Approximation Theory 5) Wavelet Analysis 6) Boundary Value Problem 7) Probability and Stochastic Processes 8) Theory of Distribution 9) Fuzzy Mathematics-II 10) Commutative Algebra-II 11) Deep Learning 12) Cloud Computing	Research Project (6 credits)

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Linear Algebra
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:

1. understand basic notions in Linear Algebra and use the results in developing advanced mathematics.
2. study the properties of Vector Spaces, Linear Transformations, Algebra of Linear Transformations and Inner product space in some details.
3. construct Canonical forms and Bilinear forms.
4. apply knowledge of Vector space, Linear Transformations, Canonical Forms and Bilinear Transformations.

Unit I: Elementary Basic concepts, Linear Independence and Bases, Dual Spaces, Annihilator of a subspace, Quotient Spaces. Inner product spaces, Linear Transformations.
15 Lectures

Unit II: The Algebra of Linear transformations, Characteristic Roots, Matrices of linear transformations, Eigen values and eigenvectors of a linear transformation, Canonical Forms: Similarity of linear transformations. **15 Lectures**

Unit III: Triangular form, Nilpotent transformations, Jordan Form, Trace and transpose, Determinants. **15 Lectures**

Unit IV: Hermitian, Unitary and Normal linear transformations, Bilinear Forms, Symmetric Bilinear Forms, Skew Symmetric Bilinear Forms. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book(s):

1. Herstein I. N. : Topics in Algebra, 2nd Edition, Willey Eastern Limited.
2. Hoffman, Kenneth and Kunze R: Linear Algebra, Prentice Hill of India Private Limited., 1984.

Reference Books:

1. A. R. Rao and P. Bhimashankaran, Linear Algebra, Hidustan Book Agency.
2. Surjit Singh, Linear Algebra, Vikas publishing House (1997).
3. Gilbert Strang: Introduction to Linear Algebra, Wellesley-Cambridge Press

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Real Analysis
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:
1. generalize the concept of length of interval.
2. analyze the properties of Lebesgue measurable sets.
3. demonstrate the measurable functions and their properties.
4. understand the concept of Lebesgue integration of measurable functions.
5. characterize Riemann and Lebesgue integrability.
6. prove completeness of L^P Spaces.

UNIT I:
σ-algebra and Borel Sets of Real numbers, Lebesgue Outer Measure, The sigma algebra of Lebesgue measurable sets, Outer and Inner approximation of Lebesgue Measurable Sets, Countable Additivity, Continuity and Borel-Cantelli Lemma. **15 Lectures**

UNIT II:
Nonmeasurable Sets, Lebesgue Measurable Functions: Sums, Product and Composition of Measurable Functions, Sequential Pointwise Limits and Simple Approximation, Littlewood's Three Principles (Statement and importance of Egoroff's Theorem and Lusin's Theorem) **15 Lectures**

UNIT III:
Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure, Lebesgue integral of a Measurable Non-negative Function, The General Lebesgue Integral, Characterizations of Riemann and Lebesgue Integrability. **15 Lectures**

UNIT IV:
Lebesgue's Theorem (Statement Only), Functions of Bounded Variations, Jordan's theorem, Absolutely Continuous Functions, Integrating Derivatives: Differentiating Indefinite Integrals, The L^P Spaces: Normed Linear Spaces, The Inequalities of Young, Hölder and Minkowski, The Riesz-Fischer Theorem.
15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. H. L. Royden, P.M. Fitzpatrick, Real Analysis, Fourth Edition, PHI Learning Pvt. Ltd., New Delhi, 2010

Reference Books:

1. G. de Barra, Measure Theory and Integration, New Age International (P) Ltd., 1981.
2. I. K. Rana, An Introduction to Measure and Integration, Narosa Book Company, 1997.
3. S. K. Berberian, Measure and Integration, McMillan, New York, 1965.
4. P. K. Jain, V. P. Gupta, Lebesgue measure and Integration, Wiley Easter Limited, 1986.
5. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill Book Co, 1964.
6. P. K. Halmos, Measure Theory, Van Nostrand, 1950.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Ordinary Differential Equations

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. study basic notions in Differential Equations and use the results in developing advanced mathematics.
2. solve problems modeled by linear differential equations.
3. use power series methods to solve differential equations about ordinary points and regular singular points.
4. construct approximate solutions using method of successive approximation.
5. establish uniqueness of solutions.

Unit I : Linear differential equations with constant coefficients: The second order homogeneous equation, initial value problems for second order equations, linear dependence and independence, formula for the Wronskian, the non-homogeneous equations of order two.

15 Lectures

Unit II: The homogeneous equations of order n, initial value problems for the nth order equations, the non-homogeneous equation of nth order. Linear equations with variable coefficients: Initial value problems for the homogeneous equations. Solutions of the homogeneous equations, the Wronskian and linear independence. **15 Lectures**

Unit III: Reduction of the order of a homogeneous equation, the non-homogenous equations, homogeneous equations with analytic coefficients, the Legendre equations. Linear equations with regular singular points: The Euler equations, second order equations with regular singular points.

15 Lectures

Unit IV: The Bessel equation, regular singular points at infinity. Existence and uniqueness of solutions: The method of successive approximations, the Lipschitz condition, convergence of the successive approximation. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended books:

1. E. A. Coddington: An introduction to ordinary differential equations. (2012) Prentice Hall of India Pvt.Ltd. New Delhi.

Reference books:

1. G. Birkoff and G.G.Rota, Ordinary differential equations, John Willey and Sons.
2. G.F. Simmons, Differential Equations with Applications and Historical note, McGraw-Hill, Inc. New York. (1972).
3. E.A. Coddington and Levinson, Theory of ordinary differential equations, McGraw-Hill, New York(1955).
4. E.D. Rainvills, Elementary differential equations, The Macmillan company, New York, (1964).

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Numerical Analysis - I

Total Credits: 02

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) apply the methods to solve linear and nonlinear equations.

2) find numerical integration and analyze error in computation.

3) solve differential equations using various numerical methods.

4) determine eigen values and eigen vectors of a square matrix.

5) construct LU decomposition of a square matrix.

Unit I: Transcendental & polynomial equations: Bisection method, Iteration methods based on First degree equation (Secant method, Regula-Falsi method and Newton-Raphson method). Rate of Convergence, Iterative methods (Birge-Vieta method and Bairstow method).

15 Lectures

Unit II: System of linear algebraic equations and eigen value problems: Matrix factorization methods (Doolittle's method, Crout's method), Iteration methods (Jacobi iteration method, Gauss-Seidel iteration method), convergence analysis of iterative methods, Eigen values and eigenvectors, Gerschgorin theorem, Brauer theorem, Jacobi method for symmetric matrices, Power method.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical methods for scientific and Engineering Computation (Fifth Edition), New Age International Publishers 2007.

Reference Books:

1. S. S. Sastry, Introductory methods of Numerical Analysis (Fifth Edition), PHI learning Private Limited, New Delhi 2012.
2. D. Kincaid, W. Cheney, Numerical Analysis Mathematics of Scientific Computing (Third Edition), American Mathematical Society.
3. J.C. Butcher, Numerical methods for ordinary differential equations (Second Edition), John Wiley & Sons Ltd, 2008.
4. Kendall E. Atkinson, An Introduction to Numerical Analysis (Second Edition), John Wiley & Sons 1988.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Combinatorics

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. describe Pigeonhole principle and use it to solve problems.
2. use definitions and theorems from memory to construct solutions to problems
3. use Burnside Frobenius Theorem in counting's.
4. use various counting techniques to solve various problems.
5. apply combinatorial ideas to practical problems.
6. improve mathematical verbal communication skills.

Unit I: The sum rule and product rule, permutations and combinations, the Pigeonhole principle, Ramsay numbers, Catalan numbers, sterling numbers. **15 Lectures**

Unit II: Further basic tools, generalized permutations and combinations sequences and selections, the inclusion and exclusion principle, systems of distinct representatives, solved problems derangements and other constrain derangements. **15 Lectures**

Unit III: Combinatorial number theory, the permanent of a matrix, Rook polynomials and Hit polynomials, SDR and coverings, (Sperners theorem and Symmetric chain decomposition, posets and Dilworth's theorem) statements. **15 Lectures**

Unit IV: Generating functions and recurrence relations, ordinary and exponential generating functions, partitions of a positive integer, recurrence relations, algebraic solutions of linear recurrence relations with constant coefficients and solutions of recurrence relations using generating functions. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. V. K. Balkrishnan: Combiactorics, Shaums Outlines Series, Mc Grow Hill Inc.

Reference Books:

1. Richard Brualdi – Introductory Combinatosics North Holland.
2. V. Krishnamurthy: Combinatorics, E. W. Press
3. A. Tucker: Combinatorics, John Wiley & Sons, Inc
4. C. Vasudev, Theory and Problems of Combinatorics, New Age International.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Differential Geometry

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. find the directional derivatives of the functions.
2. compare the unit-speed and arbitrary-speed curves.
3. apply the Frenet formulas to analyze the curves.
4. examine whether the given set in R3 is a surface.
5. construct the parametrizations of different surfaces.
6. formulate different types of curvatures of given surface.

Unit I: Euclidean space, tangent vectors, directional derivatives, curves in R3, and reparametrization of curves, standard curves, speed of curve, length of curve, mappings **15 Lectures**

Unit II: Mappings, the Frenet formulas, arbitrary-speed curves, covariant derivatives, isometries of R3, orthogonal transformations. **15 Lectures**

Unit III: Coordinate patches, surface in R3, simple surface, cylinder surface, surface of revolution, parametrization of a region, parametrization of cylinder and surface of revolution, smooth overlapping patches, tangent and normal vector fields on a surface. **15 Lectures**

Unit IV: The shape operator of surface M in R3, normal curvature, principal curvatures, Gaussian and mean curvatures, Umbilic points, fundamental forms of a surface, computational techniques. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above units.

Recommended Books:

1. O'Neill, B., Elementary Differential geometry, Academic Press, Revised Edition 2006.

Reference Books:

1. D. Somasundaram, Differential Geometry- First Course, Narosa Publishing House, New Dehli, 2010.
2. Nirmala Prakash, Differential Geometry, Tata Mcgraw Hill, 1981.
3. K. S. Amur and et al., Differential Geometry, Narosa Publishing House, 2010.
4. Millman, R. and Parker, G. D. Elements of Differential Geometry, Prentice-Hall of India Pvt. Ltd. 1977.
5. Hicks, N. , Notes on Differential Geometry, Princeton University Press (1968)

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Integral Transforms

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. describe the ideas of different types of integral transforms.
2. evaluate the integral transforms of various functions.
3. apply technique of Fourier and Laplace transforms to solve ordinary and partial differential equations.
4. analyze the properties of Fourier transforms and Laplace transforms
5. apply Z- transform to solve difference equations.

UNIT 1: The Laplace Transform, The Transforms of Some Typical Functions, Basic Operational Properties, The inverse Laplace Transform, Applications Involving Laplace Transforms, Evaluating Integrals, Solutions of ODEs, Solutions of PDEs.

15 Lectures

UNIT 2: Fourier Integrals and Fourier Transforms: Fourier Integral Representations, Proof of the Fourier Integral Theorem, Fourier Transform Pairs, Properties of the Fourier Transform, The Convolution Integrals of Fourier.

15 Lectures

UNIT 3: Applications Involving Fourier Transforms: Boundary Value Problems, Heat Conduction in Solids, Mechanical Vibrations, Mellin Transform: Evaluation of Mellin transforms, Complex variable method and Applications.

15 Lectures

UNIT 4: The Henkel Transforms: Evaluation of Henkel transforms, Applications of transform. Finite Transforms: Finite Fourier transform, Z- transform, Solutions of difference equations using Z Transform.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. Larry Andrews, Bhimsen Shivamoggi, Integral Transforms for Engineers, Prentice Hall of India, New Delhi, 2005.

Reference Books:

1. Lokenath Debnath & Damba Bhatta, Integral Fransforms and their applicaton (2nd Ed), Chapman & Hall/CRC (2007).
2. I. N. Sneddon, Fourier Transforms, McGraw Hill, 1951.
3. Bracemell, Fourier Transforms and Its Applications, McGraw-Hill, 3rd Edition, 1999.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Theory of Computation

Total Credits: 04

Course Out comes: Upon successful completion of this course, the student will be able to:

1. derive the Myhill Nerode theorem.
2. understand context free grammars.
3. explain the pumping lemma for context free languages.
4. describe Churchs hypothesis.

Unit I: Review of strings, alphabets, languages, finite automata, regular sets: the pumping lemma for regular sets, closure properties of regular sets, decision algorithm for regular sets, the Myhill Nerode theorem and minimization of finite automata. **15Lectures**

Unit II: Definition of a context free grammer, more example sincluding some familiar languages, unions, concatenations and *'s of CFLS derivation trees and ambiguity, anun ambiguous CFG for algebraic expressions. **15Lectures**

Unit III: Simplified forms and normal forms, Pushdown automata: introduction by way an example, definition, deterministic pushdown automata, a PDA corresponding to a given context free former, a context free grammer corresponding to a given PDA, parsing context free and non context free languages. **15Lectures**

Unit IV: The pumping lemma for context free languages, intersections and complements of context free languages, turing machines: introduction, the turing machine models, computable languages and functions, techniques for turing machine construction, Modification to turing machines, Churchs hypothesis, turing machines as enumerators. **15Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommends Book

1. John C. Martin: Introduction to Languages and the theory of computation, Tata McGraw Hill publishing company limited New Delhi1998.

Reference Books

1. K. L. P. Mishra and N. Chandrashekharan : Theory of computer science, Prentice Hill of India Pvt. Ltd. 2001.
2. John Hopcroft and J. Ullman: Introduction to Automata theory, Languages and Computation, Narosa Publishers 1993.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Graph Theory-I
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. classify the graphs and solve the related problems.
2. understand Euler Graph and Hamiltonian Graph to solve problems.
3. use matching's to solve optimal assignment problems.
4. solve network problems
5. solve graph theoretic problems and apply algorithms

Unit I: Trees and connectivity: definitions and simple properties, bridges, spanning trees, cut vertices and connectivity. Euler tours: Eular graphs, properties of Euler graph, the Chinese postman problem.

15 Lectures

Unit II: Hamiltonian Cycles: Hamiltonian graphs, the travelling salesman problem, matching's and augmenting paths, the marriage problem.

15Lectures

Unit III: The personal assignment problem, the optimal assignment problem, a Chinese postman problem postscript, plane and planar graphs, Eulers formula, platonic bodies, Kurotowskis theorem.

15 Lectures

Unit IV: Vertex coloring, vertex coloring algorithms, critical graphs, cliques, edge coloring, map coloring, directed graphs: definition, indegree and outdegree, tournaments, traffic flow.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. John Clark and Derek Holton: A First Look at Graph Theory, Allied Publishers Ltd. Bombay.

References Books:

1. Douglas B. West: Introduction to Graph Theory, Pearson Education Asia.
2. F. Harary- Graph Theory, Narosa Publishing House(1989)
3. K. R. Parthsarthy: Basic Graph Theory, Tata McGraw Hill publishing Co. Ltd. New Delhi

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Lattice Theory–I
Total Credits: 04
Course Outcomes: On successful completion of this course student will be able

1. Acquire thorough knowledge of fundamental notions from lattice theory and properties of lattices
2. To learn Modular and Distributive lattice
3. To learn about Boolean algebra
4. To know Stone Algebra
5. To solve individually and creatively advanced problems of lattice theory and also problems connected with its applications to mathematics

Unit I: Posets: definition and examples, two definitions of lattices and their equivalence, examples of lattices, representation of lattices, some algebraic concepts, homomorphism, isomorphism and isotone maps, Polynomials, identities and inequalities.

15 lectures

Unit II: Definition and examples of Free lattices, special elements. Distributive lattices– properties and characterizations. Modular lattices–properties and characterizations, congruence relations.

15 lectures

Unit III: Boolean algebras– properties and characterizations, ideals and filters in lattices, lattice of all ideals I(L), Stone's theorem and its consequences, distributive, standard and neutral elements.

15 lectures

Unit IV: Pseudocomplementation, Pseudo complemented lattices. S(L) and D(L) – special subsets of pseudo-complemented lattices, distributive pseudo complemented lattice, Stone lattices – properties and characterizations.

15 lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

2) George Grätzer, General Lattice Theory, Birkhäuser Verlag (SecondEdition).

Reference Books:

1) G. Birkhoff, Lattice Theory, Amer. Math. Soc. Coll. Publications, Third Edition1973.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Linear programming and its applications
Total Credits: 04

Course outcomes: Upon successful completion of this course, the student will be able to --
1. Recognize convex sets and convex functions.
2. Calculate maximum and minimum value of a function of several variables.
3. Solve LPP by simplex and dual simplex methods.

Unit – I: General formulation of linear programming problem, Slack and surplus variables, standard form of LPP, Solution of LPP, Feasible solution of LPP, Basic solution , Basic feasible solution, Optimum Basic feasible solution, unbounded solution, Lines and hyperplanes, Convex sets, polyhedron convex set, extreme points of a convex set, convex combination of vectors, convex hull , convex polyhedron, convex function, maxima and minima of functions of several variables. **15 lectures**

Unit -II : Introduction to linear programming problems ,fundamental theorem of linear programming, computational procedure of a simplex method, examples . Two phase method, Examples, big M method , disadvantages of big M method over two phase method , problem of degeneracy, Resolution of degeneracy, unbounded solutions, non-existing feasible solutions **15 lectures**

Unit -III : Duality in linear programming, rules for converting any primal into its dual, Duality theorems, fundamental duality theorem, The dual simplex method , Computational procedure of dual simplex method, examples. **15 lectures**

Unit – IV: Integer linear programming: Importance of integer Programming problems, Gomory's all IPP Method, Gomorian slack variable, Construction of Gomory's Constraints, Gomory's cutting plane Algorithm, Computational procedure for the solution of IPP by Gomorys Method, The Branch and Bound method, branch and bound algorithm, concept goal programming, single goal models,multiple goal models, multiple goals with equal priorities, multiple goal with priorities, multiple goals with priorities and weights, formulation of goal programming models, methodology of solution procedure, graphical solution. simplex method applied to GP problems. **15 lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book: 1 S.D. Sharma: Operations Research, Kedar Nath Ram Noth and co. 15th edition reprint 2009

Reference Books: 1.J.K.Sharma : Operations research
2. Kanti Swarup ,P.K.Gupta and Manmohan : Operations research, S.Chand& Co.
3. Hamady Taha : Operations Research :Mac Millan Co.
4. R.K.Gupta : Operations Research Krishna Prakashan Mandir, Meeru
5. G.Hadley : Linear programming, Oxford and IBH Publishing Co.
6. S.I.Gass : Linear Programming, Mc Graw Hill Book Co

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Dynamical Systems- I
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Classify equilibrium points of the dynamical system
2. Construct bifurcation diagrams and analyze the system for different values of parameter.
3. Relate the qualitative properties of the system with the eigen values of coefficient matrix.
4. Estimate the solution of the system using the canonical form of coefficient matrix
5. Construct the exponential of a matrix and apply it to solve the dynamical system.
6. Examine the discrete dynamical systems.

Unit I: First order systems- Qualitative Analysis: Introduction: First order linear systems, equilibrium points- classification, stability, bifurcation, phase portraits. Scalar autonomous non-linear systems, stability (linearization, equilibrium points), phase portraits- slope fields, examples, two-parameter family.

15 Lectures

Unit II: Higher order linear systems: Higher order linear ODE as a system of first order ODEs, preliminaries from algebra, eigen-values and eigen-vectors, canonical forms, solution of linear systems. Phase portraits for planar systems: Real distinct eigen-values, complex eigen-values, repeated eigen-values, phase portraits for systems in 3 dimension, changing co-ordinates

15 Lectures

Unit III: Classification of planar systems: the trace-determinant plane, yet another elegant way to find solution: the exponential of a matrix (definition, properties of exponential of a matrix, application to the solution of a system).**Discrete dynamical systems:** introduction to the discrete maps (iterative maps), orbit, periodic points, cobweb plots, fixed points of a ma

15 Lectures

Unit IV: Stability analysis of a fixed point (sink, source, saddle), Bifurcation and chaos, standard examples (logistic map, tent map, doubling map), planar linear maps.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. M. Hirsch, S. Smale and R. L. Devaney, Differential Equations, Dynamical Systems, and an Introduction to Chaos,ElsevierAcademic Press, USA, 2004.
2. Hale and Kocak, Dynamics and Bifurcations, Springer, New York.

Reference Books:

1. Alligood, Sauer and Yorke, Chaos - An Introduction to Dynamical Systems, Springer, New York.
2. Perko, Differential Equations and Dynamical Systems, Springer, New York.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Basics of Python

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Learn Basic Syntax of Python Programming.
2. Understand and implement concepts of object oriented methodology using Python.
3. Demonstrate file handling techniques.
4. Understand how Python can be used for application development.
5. Design Real life problems and think creatively about solution of them

Unit I: Introduction to Python- an interpreted high level language, interactive mode and script mode.Variables, Expressions and Statements, Variables and Types-mutable and Immutable variable and Keywords. , Operators and Operands in Python. (Arithmetic, relational and logical operators), Operator precedence .Expressions and Statements (Assignment statement); Taking input (using raw_input () and input ()) and displaying output - print statement, Comments in Python. **Conditional and Looping Construct:** if - else statement and nested if – else while, for, use of range function in for, Nested loops, break, continue **15 Lectures**

Unit II: Functions : Built-In Function, invoking built in functions , Functions from math, random, time & date, User Define Function . Strings: Creating, initializing and accessing the elements;String operators: +, *, in, not in, range, slice [n: m], String built in functions & methods, Strings constants defined in string module **15 Lectures**

Unit III: Lists: Concept of mutable lists, creating, initializing and accessing the elements of list, List operations. **Tuples :** Immutable concept, creating, initializing and accessing the elements in a tuple; Tuple functions: cmp(), len(), max(), min(), tuple() .**Sets :**Concept of Sets , creating, initializing and accessing the elements of ,Sets operation(Membership, union, intersection, difference, and symmetric difference. **Dictionaries:** Concept of key-value pair, creating, initializing and accessing the elements in a dictionary, Traversing, Dictionary functions & Methods **15 Lectures**

Unit IV: Modules: Executing modules as scripts, The Module Search Path, “Compiled” Python filesStandard Modules , The dir( ) Function ,Packages Importing * From a Package. I/O and **File Handling:** Output Formatting, Reading and Writing Files (text and binary mode). Exceptions Handling.. **15 Lectures**

Recommended Books:

1. Learning Python By Mark Lutz, O’Reilly Publication
2. Programming with python, A users Book, Michael Dawson, Cengage Learning

Reference Books:

1. Practical Programming: An introduction to Computer Science Using Python, second edition, Paul Gries, Jennifer Campbell, Jason Montojo, The Pragmatic Bookshelf.
2. Python for Informatics: Exploring Information, Charles Severance
3. Introduction to Python for Computational Science & Engineering (A beginner's guide), Hans Fangohr

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Web Technology
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Learn Basic Syntax of Python Programming.
2. Understand and implement concepts of object oriented methodology using Python.
3. Demonstrate file handling techniques.
4. Understand how Python can be used for application development.
5. Design Real life problems and think creatively about solution of them.

Unit I: **15 Lectures**

Introduction to internet and its applications, browsers, web servers, **Introduction to HTML:** Overview of HTML, Structure of an HTML document, Basic tags and elements, Creating your first HTML page. **HTML Text Formatting:** Headings, Paragraphs, Text formatting (bold, italic, underline), Line breaks and horizontal rules. **HTML Links:** Creating hyperlinks, Linking to external websites, Linking within the same page, Linking to email addresses. **HTML Lists:** Unordered lists, Ordered lists, Nested lists. **HTML Images:** Inserting images, Specifying image attributes, Image formats and optimization.

Unit II: **15 Lectures**

HTML Tables: Creating tables, Table headers and data cells, Spanning rows and columns. **HTML Forms:** Form structure and elements, Text fields and text areas, Checkboxes and radio buttons, Dropdown menus and selection lists, Submitting forms and form validation **HTML Semantic Elements:** Header and footer, Navigation, Sectioning elements (article, section, aside), Divisions and spans

Unit III: **15 Lectures**

Cascading Style sheets : Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning.

Unit IV: **15 Lectures**

JavaScript: Overview, Data types, variables, scope of variables, casting, data type conversion rules, conditions, Looping structure, Expressions and operators. Arrays. Built-in functions, and Built-in objects- String, Date, Math, Types of dialog boxes-alert, prompt, confirm. Custom Functions. **DOM objects:** Window, Navigator, History, Location, Screen and Document.

Recommended Books:

1. The Complete Reference HTML- Thomas A.Powell

Reference Books:

1. HTML, JavaScript, DHTML and PHP, Ivan Bayross, BPB publications, 2010 Edition
2. HTML Black Book, Steven Holzner, DreamTech Press, 2009 Edition
3. Web Technologies Black Book, Kogent Learning Solutions Inc., Dreamtech press, 2011 Edition

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Research Methodology

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. understand skill of mathematical writing
2. Understand wetting research paper
3. revise the drafts, check the proofs
4. understand the copy copyright issues
5. Type in mathematics using latex

Unit I: Mathematical Writing: What Is a Theorem?, Proofs, The Role of Examples, Definitions, Notation, Words versus Symbols, Displaying Equations, Parallelism, Dos and Don'ts of Mathematical Writing. Writing a Paper: Audience, Organization and Structure, Title, Author List, Date, Abstract, Key Words and Subject Classifications. **15 Lectures**

Unit II: Writing a Paper (Continued...): The Introduction, Review of Literature, Computational Experiments, Tables, Citations, Conclusions, Acknowledgements, Appendix, Reference List, Specifics and Deprecated Practices. Revising a Draft: How to Revise, Examples of Prose, Examples Involving Equations, Examples from My Writing, A Revised Proof, A Draft Article for Improvement. **15 Lectures**

Unit III: Publishing a Paper: Choosing a Journal, Submitting a Manuscript, The Refereeing Process, How to Referee, The Role of the Copy Editor, Checking the Proofs, Copyright Issues, SIAM Journal Article: A case study. Writing and Defending a Thesis: The Purpose of a Thesis, Content, Presentation, The Thesis Defence. **15 Lectures**

Unit IV: Quality indices of research publication: impact factor, H- index, science citation index., Using web for literature review: Google Scholar, Scopus, MathSciNet. Latex –Basic Typesetting of Mathematics, Typesetting Theorems. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. Higham Nicholas J., Handbook of writing for the mathematical sciences, SIAM, 1961.
1. LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September.https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

References:

1. Stegmann J., How to evaluate journal impact factors, Nature, 390(6660), (1997), 550-550.
2. Kaltenborn K. F. and Kuhn K, The journal impact factor as a parameter for the evaluation of researchers andresearch, Revista Espanola de Enfermedades Digestivas, 96(7), (2004), 460-476.
3. Hirsch J. E., An index to quantify an individual's scientific research output, https://arxiv.org/abs/physics/0508025
4. Garfield E., The evolution of the Science Citation Index, International Microbiology, 10, (2007), 65-69. DOI: 10.2436/20.1501.01.10
5. A Primer of Mathematical Writing, Steven G. Krantz, Universities Press Hyderabad 1998.https://arxiv.org/pdf/1612.04888.pdf 6McGraw- Hill's Concise Guide to Writing Research Papers, Carol Ellison, McGraw-Hill, New York, 2010.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester I)
(NEP-2020)
(Introduced from Academic Year 2024-25)

Title of Course: Research Methodology

Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. understand the meaning of research and concept of research design.
2. develop a research plan.
3. write a research report.
4. use of computer technology in research.
5. use latex for mathematical type setting.

Unit I: Research Methodology: An Introduction : Meaning of Research , Objectives of Research, Motivation in Research ,Types of Research , Research Approaches , Significance of Research , Research Methods versus Methodology, Research and Scientific Method , Importance of Knowing How Research is Done , Research Process , Criteria of Good Research , Problems Encountered by Researchers in India. **15 Lectures**

Unit II: Defining the Research Problem: What is a Research Problem, Selecting the Problem , Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration , Conclusion. Research Design, Meaning of Research Design, Need for Research Design , Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Conclusion, Developing a Research Plan. **15 Lectures**

Unit III: Meaning of Interpretation, Why Interpretation?, Technique of Interpretation: Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. The Computer: Its Role in Research, The Computer and Computer Technology, The Computer System, Important Characteristics, The Binary Number System, Computer Applications, Computers and Researcher. **15 Lectures**

Unit IV: What is LATEX? Simple typesetting, Fonts, Type size , Tables, Basic Typesetting of Mathematics: Superscripts and subscripts, Roots, Mathematical symbols , Custom Commands, Single equations , Groups of equations , Numbered equations, Matrices, Typesetting Theorems. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. C. R. Kothari, Research Methodology – Methods and Techniques, (Second Revised Edition), New Age International Publications,
1. LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September.

References:

2. Higham Nicholas J., Handbook of writing for the mathematical sciences, SIAM, 1961.
3. Michael Alley, *The Craft of Scientific Writing (3rd Edition)*, Springer, New York, 1996
4. Philip Reubens (General editor), *Science and Technical Writing – A Manual of Style (2nd Edition)*, Routledge, New York, 2001

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Algebra
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. study group theory and ring theory in some details.
2. introduce and discuss module structure over a ring.
3. apply Sylow theorems.
4. use homomorphism and isomorphism theorems.
5. check irreducibility of polynomials over Q using Eisenstein criteria.

Unit I: Group of permutations, Examples, Alternating Groups, Simple groups, simplicity of A_n ($n > 4$), Applications, Subnormal and Normal Series, Jordan-Holder Theorem, The Center and the Ascending Central Series, Isomorphism Theorems. **15 Lectures**

Unit II: The Zassenhaus (Butterfly) Lemma, Schreier Theorem, Group action on a set, fixed sets and isotropy subgroups, Orbits, Applications of G-Sets to Counting, Burnside theorem, p-groups, The Sylow Theorems.

15 Lectures

Unit III: Applications of Sylow theorems to p-Groups and the Class equation, Further Applications, Polynomial in an Indeterminate, Polynomial rings, The evaluation Homomorphisms, Factorization of Polynomials over Fields**,** The Division Algorithm in F[x], Irreducible Polynomials, Eisenstein criteria, Ideal Structure in F[x], Uniqueness of Factorization in F[x]. **15 Lectures**

Unit IV: Principal Ideal Domain (PID), Uniqueness of Factorization Domain(UFD), Gauss lemma, Introduction and Definition of Euclidean Domain, Arithmetic in Euclidean Domains. Definitions and Examples of Modules, Direct Sums, Free Modules, sub-modules, Quotient Modules, Homomorphism, Simple Modules. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book(s):

1. John B. Fraleigh , A first course in Abstract Algebra (Third Edition), Narosa publishing house, New Delhi.
2. C. Musili, Introduction to Rings and Modules (Second Revised Edition), Narosa Publishing house, New Delhi.

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Edition), Narosa Publishing house, New Delhi.
2. Bhattacharya, Jain and Nagpal, Basic Abstract Algebra, 2nd edition, Narosa Publishing House, New Delhi.
3. I. N. Herstein, Topics in Algebra, Vikas Publishing House.
4. N. Jacobson, Basic Algebra, Hind Publishing Corporation, 1984.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Topology
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
1. built foundations for future study in analysis, in geometry, and in algebraic topology.
2. introduce the fundamental concepts in topological spaces.
3. acquire demonstrable knowledge of topological spaces, product spaces, and continuous functions on topological spaces.
4. identify compact and connected sets in topological spaces.
5. use Separation and countability axioms, Urysohn lemma, Urysohn metrization.

Unit I: Topological Spaces, Basis and Subbasis for a Topology, The Order Topology, The Product Topology on $X \times Y$, The Subspace Topology. **15 Lectures**

Unit II: Closed Sets , Closure and Interior of a Set, Limit Points, Hausdorff Spaces, Continuity of Functions, Homeomorphisms, The Product Topology, The Metric Topology. **15 Lectures**

Unit III: Connected Spaces, Connected Subspaces of the Real Line, Components and Local Connectedness, Compact Spaces, Compact Subspaces of the Real Line. **15 Lectures**

Unit IV: The Countability Axioms, The Separation Axioms, Normal Spaces, The Urysohn Lemma, The Urysohn Metrization Theorem (Only statement and its importance), The Tietze Extension Theorem (Only statement and its importance). **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. J. R. Munkers, Topology, Second Edition, Pearson Education (Singapore), 2000.

Reference Books:

1. W. J. Pervin, Foundations of General Topology, Academic Press, New York, 1964.
2. J. L. Kelley, General Topology, Springer-Verlag, New York, 1955.
3. S. Willard, General Topology, Addison-Wesley Publishing Company, 1970.
4. K. D. Joshi, Introduction to General Topology, New Age International, 1983.
   G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Company, New Delhi, 1963.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Advanced Calculus
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
(i) Analyze convergence of sequences and series, double sequences and double series
(ii) Analyze convergence of sequences and series of functions
(iii)check differentiability of functions of several variables
(iv) Apply inverse and implicit function theorems for functions of several variables

Unit I : Sequences and series of functions: Pointwise convergence of sequences of functions, Examples of sequences of real valued functions, Definition of uniform convergence, Uniform convergence and continuity, Cauchy condition for uniform convergence, Uniform convergence and Riemann integration, Uniform convergence and differentiation

15 Lectures

Unit II: Rearrangement of series, subseries, Double sequences, Double series, rearrangement of double series, sufficient condition for equality of iterated series, multiplication of series, Cesaro summability, sufficient conditions for uniform convergence of series, uniform convergence and double sequences, mean convergence, Taylor series generated by a function, Bernstein's theorem, binomial series.

15 Lectures

Unit III: Multivariable differential Calculus: The Directional derivatives, directional derivatives and continuity, total derivative, total derivatives expressed in terms of partial derivatives, The matrix of linear function, mean value theorem for differentiable functions, A sufficient condition for differentiability, sufficient condition for equality of mixed partial derivatives, Taylor's formula for functions from R^n to R^1

15 Lectures

Unit IV: Implicit functions: Functions of several variables, Linear transformations, Differentiation, Contraction principle, The inverse function theorem, The implicit function theorem and their applications.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended books:

1. Mathematical Analysis, Apostal, Second Edition, Narosa Publishing House.1974

Reference books:

1.Principles of mathematical Analysis, Walter Rudin, third Edition, McGraw Hill book company
2. Calculus Vol. I , Vol II, Tom M. Apostol, Second EditionWiley India Pvt. Ltd.
3. W.Fleming, Functions of several Variables,2nd Edition ,Springer Verlag, 1977.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Numerical Analysis - II
Total Credits: 02

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) apply the methods to solve linear and nonlinear equations.
2) find numerical integration and analyze error in computation.
3) solve differential equations using various numerical methods.
4) determine eigen values and eigen vectors of a square matrix.
5) construct LU decomposition of a square matrix.

Unit I: Interpolation, differentiation and integration: Lagrange and Newton interpolations, Truncation error bounds, Newtons divided difference interpolation, finite difference operators, numerical differentiation, methods based on interpolation, numerical integration, methods based on interpolation, error analysis, Newton-Cotes methods, Error estimates for trapezoidal and Simpson's rule.

15 Lectures

Unit II: Numerical solution of differential equations: Euler method, analysis of Euler method, Backward Euler method, mid-point method, order of a method, Taylor series method, Explicit Runge-Kutta methods of order two and four, convergence and stability of numerical methods, Truncation error, error analysis.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical methods for scientific and Engineering Computation (Fifth Edition), New Age International Publishers 2007.

Reference Books:

1. S. S. Sastry, Introductory methods of Numerical Analysis (Fifth Edition), PHI learning Private Limited, New Delhi 2012.
2. D. Kincaid, W. Cheney, Numerical Analysis Mathematics of Scientific Computing (Third Edition), American Mathematical Society.
3. J.C. Butcher, Numerical methods for ordinary differential equations (Second Edition), John Wiley & Sons Ltd, 2008.
4. Kendall E. Atkinson, An Introduction to Numerical Analysis (Second Edition), John Wiley & Sons 1988.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Number Theory
Total Credits: 04

Course Outcome-: Upon successful completion of this course, the student will be able to:-

1. learn more advanced properties of primes and pseudo primes.
2. apply Mobius Inversion formula to number theoretic functions.
3. explore basic idea of cryptography.
4. understand concept of primitive roots and index of an integer relative to a given primitive root.
5. derive Quadratic reciprocity law and its apply to solve quadratic congruences.

Unit I: Review of divisibility: The division algorithm, G.C.D., Euclidean algorithm, Diophantine equation ax + by = c. Primes and their distribution : Fundamental theorem of Arithmetic, The Goldbach Conjecture. **15 Lectures**

Unit II : Congruences : Properties of Congruences, Linear congruences, Special divisibility tests. Fermat's theorem : Fermat's factorization method, Little theorem, Wilsons theorem. Number theoretic functions : The functions τ and σ. The Mobius Inversion formula, The greatest integer function. **15 Lectures**

Unit III: Euler's Generalization of Fermat's theorem: Euler's phi function, Euler's theorem, properties of phi function, An application to Cryptography. Primitive roots : The order of an integer modulo n. **15 Lectures**

Unit IV: Primitive roots for primes, composite numbers having primitive roots, The theory of Indices. The Quadratic reciprocity law: Eulerian criteria, the Legendre symbol and its properties, quadratic reciprocity, quadratic reciprocity with composite moduli .

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books :

1. D.M.Burton : Elementary Number Theory, Seventh Ed.MacGraw Hill Education(India)Edition 2012, Chennai.

Reference Books :

1. S.B.Malik :Baisc Number theory, Vikas publishing House.
2. George E.Andrews : Number Theory, Hindusthan Pub. Corp.(1972).
3. Niven, Zuckerman : An Introduction to Theory of Numbers. John Wiley & Sons.
4. S. G. Telang , Number Theory, Tata Mc.Graw-Hill Publishing Co., New Delhi.
5. M.B. Nathanson, Methods in Number Theory, Springer(2009).

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Advanced Algebra
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to :

1) Classify the ideals to solve the related problems.
2) Understand Arminian and Noetherian modules.
3) Apply integral extensions for going up and going down theorem.
4) Use Nakayama Lemma for further development in Noetherian.

Unit I:Zero-divisirs. Nilpotent elements. Units, Prime ideals and maximal ideals, Nilradical and Jacobson radical, Operations on ideals, Extension, and contraction. **15 Lectures**

Unit II: Operations on sub modules, Direct sum and product of sub modules, Finitely generated modules, Exact sequences, Tensor product of modules. **15 Lectures**

Unit III: Integral dependence, The going-up theorem. Integrally closed integral domains.The going-down theorem, Chain conditions. **15 Lectures**

Unit IV: Primary decomposition in Notherian rings, Artinian rings, Discrete valuation rings, Dedekind domains, Fractional ideals. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. M.F.Atiyah and I.G. MacDonald – Introduction to Commutative Algebra, Addison Wesley publishing company

Reference Books:

1. M.D. Larsen and P.J. McCarthy: Multiplicative theory of ideals, Academic press ,1971
2. D.G.Northcot ,Idealtheory, Cambridge University, press 1953
3. Oscar Zariski and P.Samual – Commutative Algebra Vol I, Affiliated East West Press pvt. Ltd. New Delhi.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Difference Equations
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
1. understand difference calculus
2. to solve linear difference equations
3. use Z-transform to slove difference equations
4. investigate stability theory

Unit I: The Difference Operator, Shift operator, Falling factorial power, binomial coefficient, Summation, General properties of indefinite sums, Generating Functions and Approximate Summation, Bernoulli polynomials and numbers, Euler Summation formula, First order equations, General results for linear equations

15 Lectures

Unit II: Solving linear equations, Solving System of linear equations with constant coefficients, Method of Variation of parameters, Applications, Equations with variable coefficients, Nonlinear equations that can be linearized.

15 Lectures

Unit III: The Z-transform: Properties, initial and final value theorem, partial sum theorem, convolution theorem, Inverse Z-transforms, Solution of difference equation with constant coefficients by Z-transforms, Stability Theory: Initial Value Problems for linear systems, the Putzer algorithm, Stability of linear systems **15 Lectures**

Unit IV: Phase plane analysis for linear systems, Fundamental matrices and floquet theory, Discrete Floquet theorem, Floquet Multipliers, Stability theorem for Floquet systems stability of nonlinear system **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. Walter Kelley and Allan Peterson, Difference Equations, An Introduction with Applications, Academic Press (1991)

Reference Books:

2. Calvin Ahlbrant and Allan Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations, Kluwer (1996).
3. Saber Elaydi, An Introduction to Difference Equations, Springer (1999).

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Algebraic Automata Theory
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
1. understand semigroup relation.
2. explain Mealy machine.
3. derive orthogonal partitions.
4. describe admissible subset system decomposition.

Unit I: Semigroup Relation, semigroup, group, permutation group, products and homomorphisms. **15 Lectures**

Unit II: Machine and semigroup: State machines, their semigroups, homomorphisms, quotients, Coverings, Mealy machine. **15 Lectures**

Unit III: Decompositions: Orthogonal Partitions, admissible partitions, permutation reset machines, group machines . **15 Lectures**

Unit IV: Connected transformation semigroups, automorphism decompositions, Admissible subset system decomposition. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:
1. Holcombe M. L.: Algebraic Automata Theory, Cambridge University Press.

Reference Books:
1. Arbib M. A.: Theory of abstract automata, PrenticeHall
2. Eilenberg, S.: Automata, Languages and machine
3. Ginburg A.: Algebraic theory of automata, Academic press.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Graph Theory –II
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. understand properties of graphs in terms of matrices.
2. use of matching of bipartite graph to solve various problems
3. compute Laplacian eigenvalues.
4. find energy of graph using its matrix.
5. classification of trees using properties of matrix.

Unit I: Incidence matrix: rank, minors, path matrix, integer generalized inverse, Moore-Perose inverse, 0-1incidence matrix, matching's in bipartite graphs. **15 Lectures**

Unit II: Adjacency matrix, eigen values of some graphs, determinant, bounds, energy of graph, anti-adjacency matrix of directed graph, non-singular trees. **15 Lectures**

Unit III: Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorem, bounds for Laplacian special radius, Edge-Laplacian of a tree, cycles. **15 Lectures**

Unit IV: Cuts, fundamental cycles and fundamental cut, fundamental matrices, minors. Regular Graphs: Perron –Frobinius theory, adjacency algebra of regular graphs, strongly regular graph and Friendship theorem, graphs with maximum energy, algebraic connectivity, classification of trees.

15 Lectures

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Book:

1. R. B. Bapat: Graphs and Matrices, Hindustan Book Agency.

References Books:

1. Douglas B.West: Introduction to Graph Theory Pearson Education Asia.
2. F. Harary- Graph Theory, Narosa Publishing House(1989).
3. K. R. Parthsarthy: Basic Graph Theory, Tata McGraw Hill publishing Co. Ltd. New Delhi.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Lattice Theory–II
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
1. analyze Congrunces and Ideals
2. check Modularity and semimodularity in given lattice
3. apply geometric closure operator
4. use Kurosh–Ore replacement property

Unit I: Congruences and Ideals: Week projective and congruences, Distributive, Standard and Neutral Ideals, Structure theorems. **15 lectures**

Unit II: Modular and Semimodular Lattices: Modular lattices, Semimodular Lattices, Geometric lattices. **15 lectures**
Unit III: Partition of Lattices, Complemented modular Lattices Direct decompositions, Kurosh – Ore theorem, Ore's theorem, sub group lattices. **15 lectures**

Unit IV: Semimodular, Lattices with Finite Length: Rank and covering Inequalities, Geometric closure operators, Semimodular Lattices and selectors, consistent semimodular lattices. **15 lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1) Lattice Theory: George Gratzer, W. H. Freeman and company,San Francisco,1971.
2) Semimodular Lattices Theory and Applications: Manfred Stern, Cambridge University Press, 1999

Reference Books:

1)Lattice Theory: G. Birkhoff, Amer. Math. Soc. Coll. Publications, Third Edition 1973.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2024-25)

Title of Course: Lattice Theory–II
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:
5. analyze Congrunces and Ideals
6. check Modularity and semimodularity in given lattice
7. apply geometric closure operator
8. use Kurosh–Ore replacement property

Unit I: Congruences and Ideals: Week projective and congruences, Distributive, Standard and Neutral Ideals, Structure theorems. **15 lectures**

Unit II: Boolean Algebra to Semimodular Lattices: Boolean Lattices, Ortholattices, and Orthomodular Lattices, Distributive and semidistributive lattices, Pseudocomplemented lattices, Complementation. **15 lectures**

Unit III: modular lattices, upper and lower semimodularity, Existence of Decomposition , The Jordan-Dedikind chain Condition. **15 lectures**

Unit IV: Semimodular, Lattices with Finite Length: Rank and covering Inequalities, Geometric closure operators, Semimodular Lattices and selectors, consistent semimodular lattices. **15 lectures**

S/T/PSS: Seminars, Tutorials, Problem solving session and group discussions on above units.

Recommended Books:

3) Lattice Theory: George Gratzer, W. H. Freeman and company,San Francisco,1971.
4) Semimodular Lattices Theory and Applications: Manfred Stern, Cambridge University Press, 1999

Reference Books:

1)Lattice Theory: G. Birkhoff, Amer. Math. Soc. Coll. Publications, Third Edition 1973.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Quantitative techniques in operations Research
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Decide policy for replacement.
2. Calculate economic lot size.
3. Derive Poisson distribution theorem and compute attributes of distribution model.
4. Identify optimal path by using CPM and PERT.

Unit I: Replacement Problems: Introduction, Failure mechanism of items, Replacement policy for items whose maintenance cost increases with time and money values is constant, Money value, Present worth factor and discount rate, Replacement policy for items whose maintenance cost increases with time and money values changes with constant rate, Individual replacement policy: Mortality theorem ,Group replacement policy. **15 lectures**

Unit – II : Inventory – Introduction, Cost involved in inventory problems, variables in inventory problem, symbols in inventory , concept of Economic Ordering Quantity(EOQ), The EOQ models without shortage: Model I (a) The economic lot size system with uniform demand. Model I (b) Economic lot size with different rates of demand in different cycles. Model I (c) Economic lot size with finite Rate of Replenishment. (EOQ production model),EOQ model with shortages: Model II(a) The EOQ with constant rate of demand, scheduling time constant, Model II (c) The production lot size model with shortages. Probabilistic inventory Models, Instantaneous demand, no set up cost model Model VI(a) Discrete case Model VI(b) continuous case ,Problems on above models. **15 lectures**

Unit – III : Queuing Theory - Queuing systems , Queuing Problems: transient and steady states,A list of symbols, traffic intensity, Probability distributions in Queuing systems: Distribution of arrivals 'The Poisson process', Properties of Poisson process of arrivals, Distribution of inter-arrival times(Exponential process).Distribution of Departures(Pure death model), Analogy of exponential service time with Poisson Arrivals Model I : (M/M/I) : (∞ /FCFS):Birth and Death model ,Solution of model, Examples on model I, Problems. **15 lectures**

Unit – IV: PERT / CPM : Applications of PERT /CPM techniques, Network diagram representation. Rules for constructing the Network diagram, Time estimates and critical path in network analysis, Examples on optimum duration and minimum duration cost, Problems **15 lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. S.D.Sharma : Operations Research Kedarnath and co. 1999

Reference Books:

1. Hamdy Taha : Operations Research, Macmillan and Co.
2. J.K. Sharma : Operations Research, Macmillan India Ltd. 1999.
3. R.K.Gupta : Operations researcTime estimates h, Krishna Prakashan Mandir, 1999

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Dynamical Systems –II
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will be able to:

1. test for the existence and uniqueness of solution of nonlinear system.
2. relate the stability of the system with its linearization.
3. distinguish between stable and unstable sets corresponding to the given system.
4. construct the local stable manifolds for the nonlinear system.
5. identify the chaotic behavior in the system by using Lyapunov exponents.

Unit I: Existence and Uniqueness : Set and topological preliminaries, function space preliminaries, existence and uniqueness theorem, dependence on initial conditions and parameters, the maximal interval of existence. **15 Lectures**

Unit II: Dynamical Systems: Definitions, flows, global existence of solutions, linearization, stability and Lyapunov functions, topological conjugacy and equivalence, Hartman-Grobman theorem, Omega-limit sets. **15 Lectures**

Unit III: Invariant Manifolds: Stable and unstable sets, Heteroclinic orbits, stable manifolds, local stable manifold theorem, Poincare-Bendixson theorem. **15 Lectures**

Unit IV: Chaotic Dynamics: Chaos, Lyapunov Exponents, properties of Lyapunov exponents, computing exponents, use of computer softwares to solve problems in dynamical systems. **15 Lectures**

Seminars, Tutorials, Problem solving session and group discussions on above four units

Recommended Books:

1. Meiss, James D. Differential Dynamical Systems. Vol. 14.Siam, 2007.

Reference Books:

1. M. Hirsch, S. Smale and R. L. Devaney, Differential Equations, Dynamical Systems,and an Introduction to Chaos,ElsevierAcademic Press, USA, 2004.
2. Strogatz, Nonlinear Dynamics and Chaos, Perseus Books, New York.
3. Wiggins, Introduction to Applied nonlinear Dynamics and Chaos, Springer, New York.
4. Arrowsmith and Place, Dynamical Systems: Differential Equations, Maps and Chaotic Behavior, Chapman and Hall, London.
5. Perko,Differential Equations and Dynamical Systems, Springer, New York.
6. Alligood, Sauer and YorkeChaos ,An Introduction to Dynamical Systems, Springer, New York.

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: Data Science with Python
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Illustrate the Object-oriented Programming concepts in Python.
2. Demonstrate the basic database design for storing data as part of a multi-step data gathering, analysis, and processing.
3. Implement GUI applications
4. Visualize the data and analyze it.

Unit I: Introduction of OOPs: Class and object, Attributes, Methods, Overloading, Overriding, Data hiding, **Inheritance:** Single Inheritance, Multilevel Inheritance, Multiple Inheritance, Hybrid Inheritance, Hierarchal Inheritance, IS-A Relationship and HAS-A Relationship, **Polymorphism:** Duck Type Philosophy, Method Overloading, Operator Overloading, Constructor Overloading, Method Overriding, Constructor Overriding **15 Lectures**

Unit II: Numerical processing using Python: Introduction to numpy, Creation of vectors and matrices, Matrix manipulation, **Data analysis using Python**: Introduction to Pandas, Pandas data structures – Series and DataFrame, Data wrangling using pandas, Loading a dataset into a dataframe, Selecting Columns from a dataframe, Selecting Rows from a dataframe, Adding new data in a dataframe, Deleting data from a dataframe **15 Lectures**

Unit III: Data visualization using Python: Introduction to Matplotlib, Scatter plot, Line plot, Bar char, Histogram, Box plot, **GUI in Python:** Introduction to GUI building libraries, **Widgets:** Button, Canvas, Checkbutton, Entry, Frame, Label, Listbox, Menubutton, Menu, Message, Radiobutton, Scale, Scrollbar, Text, Toplevel, Spinbox, PanedWindow, LabelFrame **15 Lectures**

Unit IV: Threading in Python: Creation, Execution of threads using threading module, **Database programming:** Connecting to a database (sqlite) using Python, Sending DML and DDL queries, processing the result from a Python Program **15 Lectures**

Recommended Books:

1. Learning Python By Mark Lutz, O'Reilly Publication
2. Programming with python, A users Book, Michael Dawson, Cengage Learning

Reference Books:

1. Practical Programming: An introduction to Computer Science Using Python, second edition, Paul Gries, Jennifer Campbell, Jason Montojo, The Pragmatic Bookshelf.
2. Python for Informatics: Exploring Information, Charles Severance
3. Introduction to Python for Computational Science & Engineering (A beginner's guide), Hans Fangohr

M. Sc. Mathematics (Part I) (Level-6.0) (Semester II)
(NEP-2020)
(Introduced from Academic Year 2023-24)

Title of Course: PHP with MySQL
Total Credits: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Gain knowledge and skills for the design and construction of Website and Web Application Development using Open Source Language PHP.
2. Develop a web application using PHP technologies.
3. Demonstrate the skills and project-based experience needed for entry into web application and development careers.
4. Compare multiple web technologies to create advanced, dynamic & effective website by the using of HTML, Java script, MySQL, CSS and PHP.

Unit I: Introduction of PHP: Embedding PHP with HTML, Enhancing further, PHP Language Basics: Using variable in PHP, understanding Data types, operator and expressions. Making decisions: simple decision with if statements, switch, ternary operator, do-While loop, for statement, break, loop skip iteration, nested loop. Arrays: creating and accessing array elements, looping through arrays, multidimensional array, manipulating array. Function: calling functions, working with variable functions, own functions references, recursive functions. Strings: creating and accessing strings, searching strings, replacing text within strings and formatting strings. **15 Lectures**

Unit II: Handling HTML forms with PHP: HTML forms work, capture form data with PHP, multivalued fields, web forms with PHP, storing PHP variables in forms, create file upload forms, redirecting PHP. **Introducing MySQL Database:** Deciding how to store data, quick play with MYSQL, connecting to MYSQL from PHP, retrieving data from MYSQL with PHP. PHP CRUD with MYSQL **15 Lectures**

Unit III: Cookies: introduction to Cookie, Cookie Syntax, How to Create, Store, Retrieve and Delete Cookie. **PHP File Upload:** Create an Upload-File Form, Upload Script and Save Uploaded file, putting restrictions on uploads. **Session:** introduction to Session, Creating, Storing and Destroying Sessions. **Classes & Object:** OO Concepts, Define Class, Class Attributes, An Object, Creating an Object, Object Properties & Methods, Object constructors and destructors, Static Method, Class Inheritance, Abstract Class, Implement Inheritance **15 Lectures**

Unit IV: **File Handling in PHP :** File I/O Operations , Checking File Permissions , Local File System Manipulation , Working with CSV Files, PHP Directory Operations, **Exception Handling**: Error Handling , Definition of Exception , Standard Keywords in Exception Handling , General Structure of Exception Handling Block , Difference Between Exception and Error **15 Lectures**

Recommended Books :

1. PHP Concepts Unleashed For Novice –Evincepub Publishing byDr.P G Naik, Dr. K.S.Oza
2. PHP: A Beginners guide,TataMcgraw Hill,2009., VikramVaswani

Reference Books:

1. Matt Doyle, Beginning PHP 5.3,Wiley India Edition,2012 .
2. PHP6 and MySQL, Steve Suehring, Tim Converse and Joyce Park, Wiley India 2010
3. Beginning PHP 5.3,Wiley India Edition,2012 , Matt Doyle
4. Core PHP Programming" by Atkinson Leon, SuraskiZeev, Pearson Publication

9. Scheme of Teaching

1. In a week for each theory course 4 lectures and 1 Seminar/Tutorial/Problem Solving Session shall be conducted.
2. Each theory lecture shall be of 60 minutes.
3. Seminar/Tutorial/Problem Solving Session shall be taken batch wise. Each batch shall be of not more than 15 students.

10. Examination Pattern

Theory:

- **For 4 credit course:**
  University examinations shall be of 80 marks and internal examination of 20 marks
- **For 2 credit course:**
  University examinations shall be of 40 marks and internal examination of 10 marks

On Job Training/Field Project:

Assessment criteria of OJT/FP shall be based on final report, presentation and oral examination.

1. Student has to submit final report based on the work carried out during OJT/FP.
2. Student has to make a presentation of the work carried out during OJT/FP in front of university appointed panel of one external and one internal examiner.
3. Student has to give midterm presentation of the work carried out during OJT/FP.
4. OJT/FP Evaluation:

Midterm Presentation	20 Marks
Report and Completion certificate of OJT/FP	50 Marks
Presentation and oral examinations	30 Marks
Total	100 Marks

Research Project:

- **For 4 credit course:**

Assessment criteria of research project shall be based on final report/ dissertation, presentation and oral examinations. University examinations shall be of 80 marks and internal examination of 20 marks.

1. Research project viva by university appointed external and internal examiners.
2. Internal evaluation will be carried out by internal guide.
3. Research Project Evaluation:

Internal evaluation	20 Marks
Final report/ dissertation	50 Marks
Presentation and oral examinations	30 Marks
Total	100 Marks

- **For 6 credit course:**

Assessment criteria of research project shall be based on final report/ dissertation, presentation and oral examinations. University examinations shall be of 100 marks and internal examination of 50 marks.

1. Research project viva by university appointed external and internal examiners.
2. Internal evaluation will be carried out by internal guide.
3. Research Project Evaluation:

Internal evaluation	50 Marks
Final report/ dissertation	70 Marks
Presentation and oral examinations	30 Marks
Total	150 Marks

Research Methodology:

University examinations shall be of 80 marks and internal examination of 20 marks.

11. Nature of Question Paper and Scheme of Marking:

End Semester Assessment:

Theory:

(I) Nature of the Theory Question Papers for courses of 4 credits:

1. There shall be 7questions each carrying 16 marks.
2. Question No.1 is compulsory. It consists of objective type questions.
3. Students have to attempt any four questions from Question No.2 to Question No.7.
4. Question No. 2 to Question No.7 shall consist of short/descriptive-answer type sub-questions.
5. Duration of university theory examination of 80 marks shall be of 3 hours.

(II) Nature of the Theory Question Papers for courses of 2 credits:

1. There shall be 4 questions.
2. Question No.1 is compulsory of objective type questions carrying 8 marks.
3. Students have to attempt any two questions from Question No.2 to Question No.4. Each question carries 16 marks.
4. Duration of university theory examination of 40 marks shall be of 2 hours.

Internal Assessment:

(I) Nature of the Internal Question Papers for courses of 4 credits:

The internal examination shall be of 20 marks and may consist of objective, short, descriptive type questions.

(II) Nature of the Internal Question Papers for courses of 2 credits:

The internal examination shall be of 10 marks and may consist of objective, short, descriptive type questions.

12. Equivalence of courses

M. Sc. Part I (Semester I and II)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Credit**	**Course Code**	**Title of New Course**	**Credit**
I	CC-101	Advanced Calculus	4	MSU0325MML925H3	Advanced Calculus	4
I	CC-102	Linear Algebra	4	MSU0325MML925G1	Linear Algebra	4
I	CC-103	Complex Analysis	4	MSU0325MML925I2	Complex Analysis	4
I	CC-104	Classical Mechanics	4	MSU0325MML925I3	Classical Mechanics	4
I	CC-105	Ordinary Differential Equations	4	MSU0325MML925G3	Ordinary Differential Equations	4
I	CC-106	Number Theory	4	MSU0325MEL925H1	Number Theory	4
		Mathematical Methods	4			
II	CC-201	Real Analysis	4	MSU0325MML925G2	Real Analysis	4
II	CC-202	Algebra	4	MSU0325MML925H1	Algebra	4
II	CC-203	Topology	4	MSU0325MML925H2	Topology	4
II	CC-204	Numerical Analysis	4	MSU0325MML925G4 and MSU0325MML925H4	Numerical Analysis I and Numerical Analysis II	4
II	CC-205	Partial Differential Equations	4	MSU0325MML925J3	Partial Differential Equations	4
II	CC-206	Operations Research	4	MSU0325MEL925G7	Linear Programming and its Applications	4
		Integral Transforms	4	MSU0325MEL925G3	Integral Transforms	4