R.E. Society's

R. P. Gogate College of Arts & Science and R. V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Master of Science (M.Sc.) Mathematics Programme

Two Year Integrated Programme

Four Semesters

Syllabus for Semester : I & II

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year 2025-2026

Name of Programme	**M.Sc. Mathematics**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	1) Students demonstrate an understanding of commonly used facts, formulas, terminology, and definitions. Students can write well-constructed and logical mathematical proofs. 2) Students will get advanced knowledge of principles, methods and clear perception of innumerous power of mathematical ideas and tools. 3) Student will get knowledge about both pure as well as applied mathematics branches
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	The study of M.Sc. mathematics helps to 1) Inculcate critical thinking to carry out scientific investigation objectively without being biased, prepare students for pursuing research or careers in industry in mathematical sciences. 2) Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities. 3) to create Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources 4) Enhance Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

Master of Science (M.Sc) Programme
Under Choice Based Credit System (CBCS)
Course Structure

M.Sc I Subject- Mathematics
(To be implemented from Academic Year 2024-25)

M.Sc I Subject- Mathematics

Course code	Semester I	Credits	Course code	Semester II	Credits
	Major Mandatory			Major Mandatory	
23_PSMT101	Algebra I	4	23_PSMT201	Algebra II	4
23_PSMT102	Analysis I	4	23_PSMT202	Topology	4
23_PSMT103	Complex Analysis	4	23_PSMT203	Analysis II	4
23_PSMT104	Discrete Mathematics I	2	23_PSMT204	Partial Differential Equation	2
	Major Electives			Major Electives	
23_PSMT105 23_PSMT106	Ordinary Differential Equations OR Business statistics	4	23_PSMT205 23_PSMT206	Probability Theory OR Elementary number theory	4
24_PSMT107	Research Methodology	4	25_PSMT207	On Job Training	4
Total Credits		22	Total Credits		22

Teaching pattern for theory courses –
1. Four lectures per week for the courses of 4 credits
2. Two lectures per week for courses of 2 credits.
3. Each lecture will be of 60 minutes.

Note: for Sem I student will select one elective paper from the following-
1) Ordinary Differential equations
2) Business statistics

For Sem II student will select one elective paper from the following-
1) Probability theory
2) Elementary number theory

Revised syllabus of courses of Master in Science I (M.Sc. I)-Semester I with effect from academic year 2024-25

Course Code	Semester I	Credits
	Major Mandatory	
23_PSMT101	Algebra I	4
23_PSMT102	Analysis I	4
23_PSMT103	Complex Analysis	4
23_PSMT104	Discrete Mathematics I	2
	Major Electives	
23_PSMT105 23_PSMT106	Ordinary Differential Equations OR Business statistics	4
24_PSMT107	Research Methodology	4
Total Credits		22

Name of the Course	Algebra I
Course Code	23_PSMT101
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Linear algebra is the branch of mathematics concerning vector spaces, often finite or countable infinite dimensional, as well as linear mappings between such spaces. Such an investigation is initially motivated by a system of linear equations in several unknowns. Such equations are naturally represented using the formalism of matrices and vectors. Linear algebra is central to both pure and applied mathematics. For instance, abstract algebra arises by relaxing the axioms of a vector space, leading to a number of generalizations. Functional analysis studies the infinite-dimensional version of the theory of vector spaces. Combined with calculus, linear algebra facilitates the solution of linear systems of differential equations. Techniques from linear algebra are also used in analytic geometry, engineering, physics, natural sciences, computer science, computer animation, and the social sciences (particularly in economics). Because linear algebra is such a well-developed theory, nonlinear mathematical models are sometimes approximated by linear ones.

Nomenclature: Algebra I

Course Outcomes:

CO1: Students will be able to define dual space and double dual, Annihilator of a subspace, to find dimensions of a finite dimensional vector space .

CO2: Students will be able to solve a system of equations using determinants.

CO3: Students will be able to define Nilpotent operators, invariant subspaces

CO4: Students will be able to identify adjoint of a linear operator, unitary operators, self adjoint operators, normal operators , to find rank of a bilinear forms,
Sylvesters law to solve the problem**.**

Unit No.	**Units**	**No. of lectures**
1	Dual Spaces	15
2	Determinants & Characteristic Polynomial	15
3	Triangulation of matrices	15
4	Bilinear forms	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Dual Spaces**	1.1 Vector spaces, linearly independent vectors, basis of a vector space, dimensions of a vector space 1.2 kernel& image of a linear transformation, Rank - Nullity theorem, relation of linear transformation & matrices 1.3 Linear functionals, dual spaces, dual basis, annihilator, double dual. 1.4 Transpose of a linear transformation, relation between rank of linear transformation and its transpose	**15**
II	**Determinants & Characteristic Polynomial**	2.1 Rank of matrix, Matrix of a linear transformation, similar matrices 2.2 Determinants as alternating n - forms, existence & uniqueness, Laplace expansion of determinant 2.3 determinants& linear transformations, determinant of linear transformation, solution of system of linear transformation by Cramer's rule 2.4 Eigenvalues and eigen vectors of a linear transformation, characteristic polynomial, minimal polynomial, Cayley Hamilton theorem	**15**
III	**Triangulation of matrices**	3.1 Triangulable, diagonalizable linear operators 3.2 Nilpotent transformation 3.3 Jordan canonical form	**15**
IV	**Bilinear forms**	4.1 Inner product spaces, orthogonal basis, Gram - schmidt process 4.2 Adjoint of linear operator, normal operator, self adjoint	**15**

		operator, unitary operator 4.3 Bilinear forms, rank of bilinear form, non - degenerate bilinear form 4.4 Symmetric bilinear form, orthogonal basis & Sylvester's law, signature of symmetric bilinear form	

Learning Resources recommended:

1. Hoffman K and Kunze R: Linear Algebra, Prentice-Hall India.
2. I.N.Herstein: Topics in Algebra, Wiley-India.
3. Serge Lang: Linear Algebra, Springer-Verlag Undergraduate Text in Mathematics.
4. Michael Artin: Algebra, Prentice-Hall India.
5. N.S. Gopalkrishnan: University Algebra, New Age International, third edition,2015.

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Analysis I
Course Code	23_PSMT102
Class	M.Sc. I
Semester	1
No of Credits	4
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Real analysis develops a rigorous theory of integration which extends the familiar notions of calculus to a broader class of functions, and in particular provides a foundation for many concepts in probability. Real analysis is a branch of mathematics that studies the properties and applications of real numbers, sequences, functions, and other mathematical objects. It has many practical applications in fields such as engineering, economics, physics and computer science.

Nomenclature: Analysis I

Course Outcomes:

CO1 - Students will be able to understand Euclidean space, inner product on Euclidean space, norm on Euclidean space, properties of operator norm, properties of compactness of the set in $\mathbb{R}^n$,examples on open sets, closed sets, boundary of sets in Euclidean space.

CO2: Students will be able to solve the examples on total derivative, partial derivative, Directional derivatives, application of derivatives such as chain rule.

CO3: Students will be able to solve the examples on approximation of a differentiable function localized at a point, mean value theorem, contraction mapping theorem.

CO4: Students will be able to solve the examples on Riemann integration.

Unit No.	**Units**	**No. of lectures**
1	Euclidean Space	15
2	Differentiable Functions	15
3	Inverse Function Theorem and Implicit Function Theorem	15
4	Riemann Integration	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	**Euclidean Space**	1.1 norm and inner product on Euclidean space and its properties 1.2 standard topology on Euclidean space 1.3 compactness, connectedness, continuity.	**15**
2	**Differentiable Functions**	2.1 differentiability on Euclidean space 2.2 Applications of chain rule 2.3 results of total derivative, directional derivative, partial derivative. 2.4 continuously differentiable functions.	**15**
3	**Inverse Function Theorem and Implicit Function Theorem**	3.1 Mean value theorem, Taylor's expansion 3.2 maxima, minima, saddle Points. 3.2Contraction mapping theorem. Inverse function theorem, Implicit function theorem	**15**
4	**Riemann Integration**	4.1 Riemann Integrable functions 4.2 Measure zero sets, Lebesgues Theorem. 4.3 Fubini's Theorem and Applications.	**15**

Learning Resources recommended:

1. C. C. Pugh, Mathematical Analysis, Springer UTM.
2. A. Browder, Mathematical Analysis and Introduction, Springer.
3. T. Apostol, Mathematical Analysis, Narosa.
4. W. Rudin, Principals of Mathematical Analysis, McGraw-Hill India.
5. M. Spivak, Calculus on Manifolds, Harper-Collins Publishers

Evaluation Pattern

A. Continuous Internal Evaluation(40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation ((60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions, and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Complex Analysis
Course Code	23_PSMT103
Class	M.Sc. I
Semester	I
No of Credits	4
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Complex analysis, traditionally known as the theory of functions of a complex variable, is the branch of mathematical analysis that investigates functions of complex numbers. It is helpful in many branches of mathematics, including algebraic geometry, number theory, analytic combinatorics, applied mathematics; as well as in physics, including the branches of hydrodynamics, thermodynamics, and particularly quantum mechanics. By extension, use of complex analysis also has applications in engineering fields such as nuclear, aerospace, mechanical and electrical engineering.

Nomenclature: Complex Analysis

Course Outcomes:

CO1. In this course the students will learn about series of functions and power series. The concept of radius of convergence will be introduced and calculated

CO2. This course gives insight of complex integration which is different from integration of real valued functions. In particular, Cauchy integral formula will be proved.

CO3. The students will learn that if a function is once (complex) differentiable then it is infinitely many times differentiable.

CO4. Student wil study properties of Mobius transformations that have a wide variety of applications ,Cauchy-Goursat theorem, Morera's theorem, Rouche's theorem and Casorati-Weierstrass theorem.

Unit No.	**Units**	**No. of lectures**
1	Holomorphic Functions	15
2	Contour Integration and Cauchy-Goursat theorem	15
3	Holomorphic Functions and Their Properties	15
4	Residue Calculus and Mobius Transformation	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Holomorphic Functions**	1.1 Stereographic projection 1.2 Sequence and series of complex numbers 1.3 Power series of complex numbers	**15**
II	**Contour Integration and Cauchy-Goursat theorem**	2.1 Contour integration 2.2 Cauchy integral formula and applications 2.3 Power series representation of holomorphic function	**15**
III	**Holomorphic Functions and Their Properties**	3.1 Entire functions 3.2 Zeros of holomorphic functions 3.3 Isolated singularities	**15**
IV	**Residue Calculus and Mobius Transformation**	4.1 Residue Theorem and evaluation of standard types of integrals by the residue calculus method 4.2 Mobius Transformation.	**15**

Learning Resources recommended:

1. A.R. Shastri: An introduction to complex analysis, Macmillan.
2. J.W. Brown and R.V. Churchill: Complex variables and Applications, McGraw-Hill.
3. S.Lang: complex analysis, Springer.
4. J.B. Conway, Functions of one Complex variable, Springer.
5. L.V. Ahlfors: Complex analysis, McGraw Hill.

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Discrete Mathematics I
Course Code	23_PSMT104
Class	M.Sc. I
Semester	I
No of Credits	02
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Discrete mathematics used in programming language, software development, cryptography, algorithms etc. It covers some important concepts such as set theory, set theory, graph theory, logic, coding, probabilistic problems of discrete mathematics, algorithms and their complexity, permutation and combination as well. It has better reasoning power and problem- solving skills. It is an excellent tool for improving reasoning and problem-solving abilities. The problem-solving techniques are necessary for writing complicated software. Solve problems involving recurrence relations and generating functions. Construct functions and apply counting techniques on sets in the context of discrete probability.

Nomenclature: Discrete Mathematics I

Course Outcomes:

CO1:Students will able to solve Linear Diophantine equations, cubic equations by Cardanos Method, Quadratic Congruence equations, examples on multiplicativity of function d, σ and φ.

CO2 : Students will be able to understand the pigeonhole principle, inclusion exclusion principle proof of Erdos- Szekers theorem, derangement .

Unit No.	**Units**	**No. of lectures**
1	Number theory	15
2	Advanced counting	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Number theory**	1.1 Linear Diophantine equations. 1.2 Arithmetic functions σ,τ,φ and their multiplicative property. 1.3 Cardano's Method.	**15**
II	**Advanced counting**	2.1 Stirling numbers, Pigeon-hole principle 2.2 Inclusion Exclusion Principle and its applications 2.3 Derangement and Permutations ,Properties 2.4 Types of occupancy problems	**15**

Learning Resources recommended:

1. Nadkarni and Telang, Introduction to Number Theory.
2. A. Tucker: Applied Combinatorics, John Wiley & Sons.
3. Sharad S. Sane, Combinatorial Techniques, Hindustan Book Agency, 2013.

Evaluation Pattern

A. Continuous Internal Evaluation (20 marks)

Method	Marks
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	10
Assignments / seminars /viva	5
Attendance and overall performance	5

B. Semester End Evaluation (30 M)

Comprehensive written examination of 1-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I	15
2	II	15

Name of the Course	Ordinary Differential Equations
Course Code	23_PSMT105
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	An Ordinary Differential Equation (ODE) is a mathematical equation that relates a function and its derivatives and are used to model the change in a physical quantity over time. Ordinary differential equations have important applications and are a powerful tool in the study of many problems in the natural sciences and in technology; they are extensively employed in mechanics, astronomy, physics, and in many problems of chemistry and biology.

Nomenclature: Ordinary Differential Equations

Course Outcomes:

CO1: Students will be able to outline the basic concepts of existence and uniqueness of solutions of Ordinary Differential Equations (ODEs).

CO2: Students will be able to solve homogeneous and non homogeneous eqations .

CO3: Students will be able to solve initial value problem, nonhomogeneous equation of order n.

CO4: Students will be able to identify Sturm Liouville problems and to understand the special functions like Legendre's polynomials and Bessel's function.

Unit	Title	No of Lectures
1	Existence and Uniqueness of Solutions	15
2	Linear Equations with constant coefficients	15
3	Linear Equations with variable coefficients	15
4	Sturm-Liouville Problem & Qualitative Properties of Solutions	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Existence and Uniqueness of Solutions**	1.1 Existence and Uniqueness of solutions to initial value problem of first order ODE- both autonomous, non autonomous 1.2 Epsilon-approximate solutions 1.3 Lipschitz condition 1.4 Picard's method of successive approximations 1.5 System of Differential equations. Reduction of n-th order differential equations.	**15**
II	**Linear Equations with constant coefficients**	2.1 The second order homogeneous equations 2.2 Initial value problem for second order equations, Uniqueness theorem 2.3 linear dependence and independence of solutions 2.4 Wronskian 2.5 The second order non-homogeneous equations 2.6 The homogeneous equations of order n, Initial value problem for nth order Equations, The non-homogeneous equations of order n, Algebra of constant coefficient operators.	**15**
III	**Linear Equations with variable coefficients**	3.1 Initial value problem for the homogeneous equation of order n 3.2 Existence and Uniqueness theorem solution of the homogeneous equations 3.3 Wronskian and linear independence 3.4 reduction of the order of a homogeneous equation 3.5 the non-homogeneous equations of order n.	**15**
IV	**Sturm-Liouville Problem &Qualitative**	4.1 Eigenvalue problem, Eigenvalues and Eigen functions, the vibrating string problem, Sturm Liouville problems	**15**

	Properties of Solutions	4.2 homogeneous and non-homogeneous boundary conditions 4.3 orthogonality property of eigen functions Existence of Eigenvalues and Eigen functions 4.4 Power series solution of second order linear equations 4.5 ordinary points, singular points, regular singular points 4.6 existence of solution of homogeneous second order linear equation 4.7 Legendre's polynomials 4.8 Bessel functions, Properties of Bessel function, orthogonality of Bessel functions.	

Learning Resources recommended:

1. Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice- Hall of India.
2. G. F. Simmons, Differential Equations with Applications and Historical Notes, Second Edition, Tata McGraw Hill, India
3. Hurewicz W., Lectures on ordinary differential equations, M.I.T. Press.
4. Morris W. Hirsch and Stephen Smale, Differential Equations, Dynamical Systems, Linear Algebra, Elsevier.

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Business Statistics
Course Code	23_PSMT106
Class	M.Sc. I
Semester	I
No of Credits	04
Nature	Theory
Type	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	Business statistics help companies understand their present and predict their future. This can save organizations money, help them find new opportunities, and improve their efficiency. It allows product comparison between businesses. It identifies flaws and deals with uncertainties by predicting general economic fluctuations. It measures variations in product performance. It enhances the effectiveness and efficiency of business units and sales teams. It analyzes the data of market research. For all these reasons study of business statistics is very important. Students should get knowledge about this.

Nomenclature: business statistics

Course Outcomes:

CO1: Students will be able to understand types of data ,various methods of data collection.
CO2: Students will be able to understand measures of central tendencies.
CO4: Students will be able to understand the measures of dispersion.
CO4: Students will be able to understand the skewness, kurtosis.

Unit No.	Units	No. of lectures
1	Data Classification, Tabulation and Presentation	15
2	Measures of Central Tendency	15
3	Measures of Dispersion	15
4	Skewness, Moments and Kurtosis	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Data Classification, Tabulation and Presentation**	1.1 Requisites of Ideal Classification, Basis of Classification. 1.2 Frequency Distribution, Methods of Data Classification 1.3 Bi-variate Frequency Distribution, Types of Frequency Distributions. 1.4 Tabulation of Data 1.5 Graphical Presentation of Data, Advantages and Limitations of Diagrams(Graph), One-Dimensional Diagrams, Two-Dimensional Diagrams, Three-Dimensional Diagrams, Pictograms for Ideographs, Cartograms for Statistical Maps. Exploratory Data Analysis: Stem-and-Leaf Displays.	**15**
II	**Measures of Central Tendency**	2.1 Objectives of Averaging, Requisites of a Measure of Central Tendency, Arithmetic Mean of Ungrouped Data, Arithmetic Mean of Grouped (or classified)Data. Advantages and Disadvantages of Arithmetic Mean. 2.2 Weighted Arithmetic Mean. Geometric Mean Combined Geometric Mean, Weighted Geometric Mean, Advantages, Disadvantages and Applications of GM. Harmonic Mean: Advantages, Disadvantages and Applications of H.M. Relationship Between A.M, G.M.and H.M.	**15**

		2.3 Averages Position: Median, Advantages, Disadvantages and Applications of Median. PartitionValues quartiles, Deciles and Percentiles: Graphical Method for Calculating Partition Values. 2.4 Mode: Graphical Method for Calculating Mode Value. Advantages and Disadvantages of Mode Value. 2.5 Relationship Between Mean, Median and Mode, Comparison Between Measures of Central Tendency.	
III	**Measures of Dispersion**	3.1 Significance of Measuring Dispersion(Variation) 3.2 Classification of Measures of Dispersion. 3.3 Range, In-Range or Deviation. 3.4 AverageDeviation Measures: Mean Absolute Deviation, Variance and Standard Deviation, 3.5 Mathematical Properties of Standard Deviation Chebyshev'sTheorem, Coefficient of Variation.	**15**
IV	**Skewness, Moments and Kurtosis**	4.1 Measures of Skewness: Relative Measures of Skewness. 4.2 Moments: Moments About Mean,Moments About Arbitrary Point, Moments About Zero or Origin.	**15**

		4.3 Relationship Between Central Moments and Moments About Any Arbitrary Point. 4.4 Moments in Standard Units, Sheppard's Correction for Moments. 4.5 Kurtosis: Measures of Kurtosis.	

Learning Resources recommended:

1. S.C.Gupta And V.K.Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand &Sons,1994.
2 J.K.Sharma, Business Statistics, Pearson Education India,2012

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Syllabus for M.Sc. Mathematics Autonomous from the year 2023-24

Name of the Course	Research Methodology
Course Code	24_PSMT107
Class	M.Sc.I
Semester	I
No of Credits	04
Nature	Theory
Type	compulsory
Highlight revision specific to employability/ entrepreneurship/ skill development	Research methodology is a collective term for the structured process of conducting research. Research methodology seeks to inform: Why a research study has been undertaken, how the research problem has been defined, in what way and why the hypothesis has been formulated, what data have been collected and what particular method has been adopted, why particular technique of analyzing data has been used and a host of similar other questions are usually answered when we talk of research methodology concerning a research problem or study. The purpose of a research methodology is to explain the reasoning behind your approach to your research .The research methodology section of study will indicate how valid your findings are and how well-informed your paper is. It also assists future researchers planning to use the same methodology, who want to cite your study or replicate it.

Nomenclature: Research methodology

Course Outcomes:
Students will be able to
CO1: Understand fundamentals of research methods
CO2: Learn design and measurement concepts of research
CO3: Know data collection and analysis tools
CO4: Test the hypothesis and communicate the research findings effectively

Unit No.	Units	No. of lectures
1	Introduction to scientific Research	15
2	Data analysis	15
3	Methods of Scientific Research And Writing Scientific Papers	15
4	Hypothesis Testing and Communication Skills in Research	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Fundamentals of Research Methods	1.1 Definition of research, Role and objectives of research. 1.2 Importance of research, Applications and types of Research. 1.3 Creativity and innovation, Critical thinking. 1.4 Research process and steps in it, Collecting and reviewing the Literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of results And discussion.	**15**
II	Research Design and Measurement Concepts and Literature Searching	2.1 Selecting and defining a research problem, Need for research design, Features of a good research design, Different research designs, Scales of measurements, Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. 2.2 Digital: Web sources, E-journals, Journal access, Citation Index, Impact factor, H-index, E-consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs,	**15**

		preprint servers, Search engines, Scirus, Google Scholar, Scopus.	
III	Documentation, scientific writing and Academic Integrity	3.1 Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style, publications of scientific work. 3.2 Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues, Ethics in research, and case studies.	**15**
IV	Hypothesis Testing and Communication Skills in Research	4.1. Hypotheses a. Meaning, Nature of hypothesis b. Functions of Hypothesis c. Importance of Hypothesis d. Kinds of Hypothesis e. Characteristics of good hypothesis 4.2. Hypothesis testing a. Null and alternate hypothesis b. Type I and Type II errors c. Level of significance d. Power of test e. p-value 4.3 Communication skills a. Importance communication through English b. The process of communication and factors that influence communication. Sender, receiver, channel, code, topic, message, context,	**15**

		feedback, noise, filters, and barriers. c. Verbal and Nonverbal communication d. Comparison of general communication and business communication. 4.4. Presentation skills a. Structure of presentation b. Types of presentation, oral power point – Handling power point slides, organization, content, body language, gesture and voice modulation.	

Learning Resources recommended:

1. Kothari C.R., "Research Methodology, Methods and Techniques" (Second revised edition, NewAge International Publication, 2004).
2. Saravanavel P., "Research Methodology" (Kitab Mahal, Sixteenth edition, 2007).
3. Ranjit Kumar, "Research Methodology, a step-by-step guide for beginners" (Pearson education Australia, Second edition 2005).
4. Mark Saunders, Philip Lewis, Adrain Thornhiu, "Research Methods for Business students"(Pearson Education ltd, Seventh edition, 2016)
5. Research Methodology and Scientific Writing by C. George Thomas 2nd Ed. Springer

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Revised syllabus of courses of Master in Science I (M.Sc.I) at Semster-II with effect from academic year 2024-25

Course Code	Semester II	Credits
	Major Mandatory	
23_PSMT201	Algebra II	4
23_PSMT202	Topology	4
23_PSMT203	Analysis II	4
23_PSMT204	Partial Differential equation	2
	Major Electives	
23_PSMT205 23_PSMT206	Probability Theory OR Elementary number theory	4
25_PSMT207	On Job Training	4
Total Credits		22

Name of the Course	Algebra II
Course Code	23_PSMT201
Class	M.Sc. I
Semester	II
No of Credits	04
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	In mathematics more specifically algebra, **abstract algebra** or **modern algebra** is the study of algebraic structures. Algebraic structures include groups, rings, fields, modules, vector spaces, lattices and algebra over fields. The term *abstract algebra* was coined in the early 20th century to distinguish it from older parts of algebra, and more specifically from elementary algebra, the use of variables to represent numbers in computation and reasoning. Presently, the term "abstract algebra" is typically used for naming courses in mathematics education and is rarely used in advanced mathematics.

Nomenclature: Algebra II

Course Outcomes:

CO1: Students will be able to solve Dihedral groups, Matrix Groups, Automorphism Group. group homomorphism, inner automorphism.

CO2: Students will be able to apply group action and orbit stabilizer formula to solve the Problems ,to apply Sylow theorems to classify the groups of small order.

CO3: Students will be able to solve problems based on Rings, Ideals, ring homomorphisms and the Chinese remainder theorem.

CO4: Students will be able to identify Euclidean domain, Principal Ideal Domain, Unique Factorisation Domain.

Unit No.	**Units**	**No. of lectures**
1	Groups and Group Homomorphisms	15
2	Groups acting on sets and Sylow theorems	15
3	Rings and Fields	15
4	Divisibility in integral domains	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Groups and Group Homomorphisms**	1.1 Quotient groups, isomorphism theorems, 1.2 Internal& external direct product of groups 1.3 Automorphisms& inner automorphisms of a group 1.4 Statement& applications of structure theorem of abelian group	**15**
II	**Groups acting on sets and Sylow theorems**	2.1 Conjugate class of an element in a group 2.2 Class equation and its applications 2.3 Groups action on a set 2.4 Cauchy's Theorem 2.5 p - groups, Sylow theorems & applications	**15**
III	**Rings and Fields**	3.1 Prime& maximal ideals 3.2 Ring homomorphisms 3.3 Chinese remainder theorem in rings & its applications 3.4 Fields, characteristic of field 3.5 Polynomial ring, irreducible polynomials, unique factorization theorem	**15**
IV	**Divisibility in integral domains**	4.1 Euclidean domain, principal ideal domain, unique factorization domain 4.2 Prime element, irreducible element 4.3 Irreducibility criterion, Eisenstein's criterion, Gauss lemma	**15**

Learning Resources recommended:

1. Hoffman K and Kunze R: Linear Algebra, Prentice-Hall India.
2. I.N.Herstein: Topics in Algebra, Wiley-India.
3. Serge Lang: Linear Algebra, Springer-Verlag Undergraduate Text in Mathematics.
4. Michael Artin: Algebra, Prentice-Hall India.
5. N.S. Gopalkrishnan: University Algebra, New Age International, third edition,2015

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Topology
Course Code	23_PSMT202
Class	M.Sc. I
Semester	2
No of Credits	4
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Topology is a branch of mathematics concerned with the study of properties of spaces and objects that are invariant under continuous transformations. It deals with concepts such as continuity, compactness, connectedness, and more. Applications of topology include Network design, Data analysis, Robotics, Cryptography

Nomenclature: Topology

Course Outcomes:

CO1-Students will be able to form new spaces from old one using product, box and quotient topology.

CO2-Students will be able to solve problems on connectedness and path connectedness of set, connected components and path components of set.

CO3 - Students will understand first and second countable spaces,separable spaces, Lindeloff Spaces, compact spaces ,limit point compactness, local compactness, separation axioms, extension theorems such Tietze extension theorem,Tychnofftheorem,Urysohn metrization theorem.

CO4-Students will understand metrisable spaces and Tychonof theorem.

Unit No.	**Units**	**No. of lectures**
1	Topology and Topological spaces	15
2	Connected topological spaces	15
3	Compact topological spaces	15
4	Metrizable spaces and Tychonof theorem	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	**Topology and Topological spaces**	1.1 Topological spaces, basis, subbasis, types of topologies, T_0; T_1,T_2 spaces 1.2 closed sets, limit points, closure, interior 1.3 continuous functions, homeomorphism	**15**
2	**Connected topological spaces**	2.1 Quotient spaces. Connected topological spaces, 2.2 path-connected topological spaces, Connected components, path components 2.3 Countability Axioms, first and second countable spaces, Lindelof spaces.	**15**
3	**Compact topological spaces**	3.1 continuity and compactness, tube lemma, finite product of compact spaces. 3.2 Lebesgue number lemma, uniform continuity theorem, compact Hausdorff space. 3.3 Limit point compact spaces, local compactness, one point compactification.	**15**
4	**Metrizable spaces and Tychonof theorem**	4.1 Metrizable spaces, separation axioms 4.2 Urysohn lemma, Urysohn metrization theorem, Tietze extension theorem. Tychonof theorem.	**15**

Learning Resources recommended:

1. J. F. Munkres: Topology, Pearson; 2 edition (January 7, 2000).
2. G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw Hill, 2004.

Evaluation Pattern

A.

Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Analysis II
Course Code	23_PSMT203
Class	M.Sc. I
Semester	II
No of Credits	04
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	Measure theory is a branch of mathematics that deals with the study of measures and their properties. Measures are mathematical functions that assign a numerical value to sets in a certain space, and measure theory provides a framework for studying these functions and their relationships to sets and functions. Measure Theory formalizes and generalizes the notion of integration. It is essential for many advanced areas of mathematics and has applications in other fields such as physics and economics.

Nomenclature: Analysis II

Course Outcomes:

CO1: students will be able to understand the fundamentals of measure theory and be acquainted with the proofs of the fundamental theorems underlying the theory of integration.

CO2: students will be able to use the mathematical concepts such as volume, area, and integration

CO3: students will be able to understand convergence theorems.

CO4: students will be able to understand space of integrable functions.

Unit No.	**Units**	**No. of lectures**
1	Measures and Measurable Sets	15
2	Measurable functions and their Integration	15
3	Convergence Theorems on Measure space	15
4	Space of Integrable functions	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Measures and Measurable Sets**	1.1 Additive set functions, σ-algebra countable additivity 1.2 Outer measure, constructing measures, measurable sets (Definitions due to Caratheodory), measure space(X, P, μ). 1.3 properties of exterior measure 1.4 Measurable sets and Lebesgue measure, properties of measurable sets. 1.5 Existence of a subset of $\mathbb{R}$ which is not Lebesgue measurable.	**15**
II	**Measurable functions and their Integration**	2.1 Measurable functions on (X, P, μ) 2.2 simple functions, properties of measurable functions. 2.3 Integral of nonnegative simple measurable functions defined on the measure space (X, P, μ) and their properties. 2.4 Integral of a non-negative measurable function.	**15**
III	**Convergence Theorems on Measure space**	3.1 Monotone convergence theorem. 3.2 Fatou's lemma 3.3 summable functions, vector space of summable functions 3.4 Lebesgue's dominated convergence theorem. 3.5 Lebesgue integral of bounded functions over a set of finite measure 3.6 Lebesgue and Riemann integrals	**15**
IV	**Space of Integrable functions**	4.1 Borel set, Borel algebra 4.2 Signed Measures, positive set, negative set and null set. 4.3 Complex valued Lebesgue measurable functions f 4.4 Lebesgue integral of	**15**

		complex valued measurable functions. 4.5 Approximation of Lebesgue integrable functions by continuous functions. 4.6 The space $L^1(\mu)$ of integrable functions, properties of L^1 integrable functions	

Learning Resources recommended:

1. Andrew Browder, Mathematical Analysis, An Introduction, Springer Undergraduate Texts in Mathematics.
2. Elias M. Stein and Rami Shakarchi, Real Analysis, Measure Theory, Integration and Hilbert Spaces, New Age International Limited, India
3. Royden H. L. Real Analysis, PHI.
4. Terence Tao, Analysis II, Hindustan Book Agency (Second Edition).

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Partial Differential Equation
Course Code	23_PSMT204
Class	M. Sc. I
Semester	II
No of Credits	02
Nature	Theory
Type	Major mandatory
Highlight revision specific to employability/ entrepreneurship/ skill development	A **partial differential equation** (or briefly a **PDE**) is a mathematical equation that involves two or more independent variables, an unknown function (dependent on those variables), and partial derivatives of the unknown function with respect to the independent variables. Partial Differential Equations are used to mathematically formulate and thus an aid the solution of, physical and other problems involving functions of several variables, such as the propagation of heat or sound, fluid flow, elasticity, electrostatics, electrodynamics, etc. The use of partial derivatives in real world is very common. Partial Derivatives are used in basic laws of physics for example Newton's law of linear motion, maxwell's equations of Electromagnetism and Einstein's equation in General Relativity.

Nomenclature: Partial Differential Equation

Course Outcomes:

CO1 : Students are expected to understand the basic concepts and method of finding the solution of first and second order Partial Differential Equations (PDEs).

CO2 : Students will be able to know the classification of second order PDEs, singularity and fundamental solution

Unit No.	**Units**	**No. of lectures**
1	First Order Partial Differential Equations	15
2	Second Order Partial Differential Equations	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**First Order Partial Differential Equations**	1.1 First order partial differential equations in two independent variables. 1.2 Semilinear and Quasilinear equations. 1.3 Non-linear equations in two independent variables: Monge Strip and Charpit Equations 1.4 Solution to the Cauchy problem.	**15**
II	**Second Order Partial Differential Equations**	2.1 Classifications of second order partial differential equations (PDE's) 2.2 Method of reduction to normal form 2.3 Boundary value problems 2.4 Poisson's theorem	**15**

Learning Resources recommended:

1. Phoolan Prasad &Renuka Ravindran, Partial Differential Equations, Wiley EasternLimited, India.
2. F. John, Partial Differential Equations, Springer publications
3. T. Amaranath- An elementary course in partial differential equation (second edition)
4. Ian N. sneddon – Elements of Partial Differential Equation.

Evaluation Pattern

A. Continuous Internal Evaluation (20 marks)

Method	Marks
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	10
Assignments / seminars /viva	05
Attendance and overall performance	05

B. Semester End Evaluation (30 M)

Comprehensive written examination of 1-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material.

Question Paper Pattern (30M – 1 hour)

Q. No	Unit	Marks
1	I	15
2	II	15

Name of the Course	Probability Theory
Course Code	23_PSMT205
Class	M.Sc. I
Semester	II
No of Credits	04
Nature	Theory
Type	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	Probability is one of the most important branches of mathematics. It is used in almost every other area to define a random event or an event with uncertainty. The probability is important as it enables us to calculate the possible results of a random experiment statistically. It is vital in predicting the behavior of variables influenced by chance.

Nomenclature: Probability Theory

Course Outcomes:

CO1: Students will be able to explain concept of Modelling Random Experiments, Classical probability spaces, sigma-fields generated by a family of sets, sigma-field of Borel sets, Limitsuperior and limit inferior for a sequence of events.

CO2: Students will be able to earn knowledge of discrete and absolutely continuous probability measures, conditional probability, total probability formula, Bayes formula.

CO3: Students will be able to express distribution of a random variable, distribution function of a random variable, Bernoulli, Binomial, Poisson and Normal distributions

CO4: Students will be able to apply limit theorems of Probability Theory.

Unit No.	**Units**	**No. of lectures**
1	Probability basics	15
2	Probability measure	15
3	Random variables	15
4	Limit Theorems	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Probability basics**	1.1 Modelling Random Experiments: Introduction to probability, probability space, events. 1.2 Classical probability spaces: uniform probability measure, 1.3 fields, finite fields 1.4 finitely additive probability 1.5 σ-fields, σ-fields generated by a family of sets, σ-field of Borel sets 1.6 Limit superior and limit inferior for a sequence of events.	**15**
II	**Probability measure**	2.1 Probability measure, Continuity of probabilities 2.2 Discussion of Lebesgue measure on σ-field of Borel subsets of assuming its existence 2.3 Discussion of Lebesgue integral for non-negative Borel functions assuming its construction. 2.4 Discrete and absolutely continuous probability measures 2.5 conditional probability, total probability formula, Bayes formula, Independent events.	**15**
III	**Random variables**	3.1 Random variables, simple random variables, discrete and absolutely continuous random variables, 3.2 distribution of a random variable, distribution function of a random variable 3.3 Bernoulli, Binomial, Poisson and Normal distributions 3.4 Independent random variables 3.4 Expectation and variance of random variables both	**15**

		discrete and absolutely continuous.	
IV	**Limit Theorems**	4.1 Conditional expectations and their properties 4.2 Characteristic functions, Examples. 4.3 Higher moments examples 4.4 Chebyshev inequality, Weak law of large numbers 4.5 Convergence of random variables, Kolmogorov strong law of large numbers (statement only), Central limit theorem (statement only).	**15**

Learning Resources recommended:

1. M. Capinski, Tomasz Zastawniak: Probability through Problems.
2. J. F. Rosenthal: A First Look at Rigorous Probability Theory, World Scientist.
3. Kai Lai Chung, FaridAitSahlia: Elementary Probability Theory, Springer Verlag.
4. Ross, Sheldon M. A first course in probability(8th Ed), Pearson.

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	Elementary number theory
Course Code	23_PSMT206
Class	M.Sc. I
Semester	II
No of Credits	04
Nature	Theory
Type	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development	1)Number theory is the foundation of many other areas of mathematics: Number theory provides the basis for many other branches of mathematics, such as algebra, geometry, and calculus. A strong understanding of number theory is essential for further studies in these areas. 2)Number theory is used in cryptography: Number theory plays a crucial role in modern cryptography. Cryptography is the practice of protecting information from unauthorized access, and many encryption techniques are based on the properties of prime numbers and other concepts from number theory.

Nomenclature: Elementary number theory

Course Outcomes

CO1: Students will be able to define The Mobius function, the Euler function and will be able to explain the Fundamental Theorem of Arithmetic, the Euclidean Algorithm.

CO2: Students will be able to evaluate Dirichlet inverses and Mobius inversion formulaandwill be able To Classify Multiplication functions andCompletely Multiplication function.

CO3: Students will be able to interpret Residue Classes and Complete Residue Systems Linear Congruences.

CO4:Students will be able toanalyze Chinese remainder theorem Quadratic reciprocity law. And to Solve system of linear congruences using Chinese Remainder theorem

Unit No.	**Units**	**No. of lectures**
1	The Fundamental Theorem of Arithmetic	15
2	Product formula for $\emptyset_n$	15
3	Congruence	15
4	Chinese remainder theorem and its application	15

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	The Fundamental Theorem of Arithmetic	Divisibility - GCD - Prime Numbers -Fundamental theorem of Arithmetic-the Series of Reciprocal of the Primes -The Euclidean AlgorithmArithmetic function and Dirichlet Multiplication:-The Mobius function –The Euler Totient function a Relation connecting them.	**15**
II	Product formula for $\emptyset_n$	Product formula for -The Dirichlet Product of Arithmetical functions - Dirichlet inverses and Mobius inversion formula - Mangoldt function $\Lambda(n)$-Multiplication functions-Multiplication functions and Dirichlet Multiplication-Inverse of a Completely Multiplication function - Liouville'sfunction $\lambda(n)$-the Divisor functions	**15**
III	Congruence	Congruence: Definitions and Basic properties of Congruences - Residue Classes and Complete Residue Systems Linear Congruences - Reduced Residue System and Euler Fermat theoremPolynomialCongruences modulo p- Lagrange's theorem-Application of Lagrange's theorem	**15**
IV	Chinese remainder theorem and its application	Chinese remainder theorem and its application -Polynomial Congruences with prime power moduli. Quadratic residues and Quadratic reciprocity law: Quadratic residues- Legendre's symbol and its properties - Evaluation of (-1/p) and (2/p)-Gauss Lemma-the Quadratic reciprocity law and its applications.	**15**

Learning Resources recommended:

1. Tom. M.Apostol, "Introduction to Analytic Number Theory", Springer International Edition, First Indian Reprint 2010.
2. Thomas Koshy," Elementary Number Theory with Applications", Second Edition , ELSEVIER, Imprint- Academic Press.
3. David M Burton , "Elementary Number Theory," fifth Edition , Pearson Publishers.
4. K Chandrashekaran,"Introduction to Analytic Number Theory", Springer International Edition

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Online / Class Tests Online test of MCQs / Short Answer Questions / Long Answer Questions	20
Assignments / seminars /viva	10
Attendance and overall performance	10

B. Semester End Evaluation (60 M)

Comprehensive written examination of 2-hour duration will be conducted at the end of each semester to evaluate students' understanding of the course material. The examination will cover the entire syllabus and include a mix of multiple-choice questions or fill in the blanks or one line sentence, short answer questions and descriptive type questions, problems.

Question Paper Pattern (60M – 2 hours)

Q. No	Unit	Marks
1	I II III IV	3 3 3 3
2	I	12
3	II	12
4	III	12
5	IV	12

Name of the Course	On job training
Course Code	25_PSMT207
Class	M.Sc. I
Semester	II
No of Credits	04
Nature	Practical
Type	On Job training
Highlight Revision Specific to Employability/ Entrepreneurship/ Skill Development	The main objective of inclusion of On Job Training is to inculcate ability to interpret particular aspect of the study in his/ her own words. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study

Nomenclature: On Job Training

Course Outcomes

By the end of the course, students should be able to:

CO1: Gain exposure to real-world insights and apply theoretical knowledge to practical situations

CO2: Enhance skills regarding problem-solving, decision-making, and communication skills.

CO3:Understand organizational dynamics and work culture.

CO4:Build industry connections and networking opportunities.

Curriculum -

Students will be required to undertake a designated project or tasks in institutes or an organization or industry relevant to their field of study.

Report structure should involve Title Page, Certificate of Completion, Declaration, Acknowledgment, Table of Content, Executive Summery, Introduction of Company, Your Role in Organization during OJT, Challenges and Overcoming of Challenges, Conclusion, Appendices like OJT Undertaking, Draft Resume Templates etc. List of Appendices is as follows-

Appendix:

1.1 Appendix I: OJT Undertaking

1.2 Appendix II: Draft Resume Template

1.3 Appendix III: Organization Outreach Letter

1.4 Appendix IV(A/B): A) Relieving Letter of Student (for fulltime OJT) B)Relieving Letter of Student (for part time OJT)

1.5 Appendix V**:** Relieving Letter of Student from organization

1.6 Appendix VI: Student Diary (Log) Recording Format

1.7 Appendix VII: Attendance Sheet

1.8 Appendix VIII: Supervisor Evaluation of Intern

1.9 Appendix IX: Student Feedback of OJT

1.10 Appendix X: Performance for Evaluation of OJT by Institute

Appendix I: OJT Undertaking

1. Student Name:	
2. Class	
3. Roll No	
4. UID	
5. ABC ID	
6. Current Address	
7. Residence Address	
8. Email id	
9. Mobile Nos.	
10. Aadhar Number	
11. Mode of OJT	Online /Offline
I confirm that I agree with the terms, conditions, and requirements of the OJT Policy Student Signature: Date:	
I confirm that the student has attended the OJT orientation and has met all paperwork and process requirements to participate in the OJT program, and has received approval from his/her mentor. Sign of Department Faculty Coordinator Date:	

Appendix II: Draft Resume Template

Name:
Contact Number and Email ID:
Education:

(HEI / COLLEGE) Name: Year:
Degree:
Specialization:
SGPA:(PG SEMESTER I)
College Name: <bachelor's degree> Year:
Degree:
Specialization:
CGPA:
OJT / Work Experience – Yes / No

If YES
Organization: Year:
Project:
Brief:
Academic Experience:

Other Achievements and Personal Interests

- List other achievements also in reverse chronological order
- Leadership positions held outside of your formal work environment
- Personal interests and accomplishments that will distinguish you from other applicants
- Volunteer service/Social Work

Appendix III: Organization Outreach Letter

< (HEI) /College Name Letter Head>

To,
The (Manager, HR) .....
.....

Subject: Request for 120 hours OJT of Students pursuing < >
Dear Sir,
The college (HEI) name established in <year>, < (HEI /college name) >, Maharashtra reflects the vision of leading industrialists and educationalists. Institute is accredited with '< >' grade by NAAC in [Month year]. The HEI /college name has been recognized about it's over all academic excellence and infrastructure.
In view of the above, I request your good self to allow our following (no. of students) students for practical raining in your esteemed organization. Kindly accord your permission and give at least one-week time for students to join training after confirmation.

Sr. No.	Name	Roll no.	Year	Department

The resumes of these students are attached with this letter. If vacancies exist, kindly do plan for Interviews for the students in above branches.

A line of confirmation will be highly appreciated.

Yours sincerely,

Nodal Officer/TPO
< HEI /college name and Date>

Appendix IV: A) Relieving Letter of Student (for fulltime OJT)

< HEI /college name Letter Head>

To,
The General Manager (HR) .....
.....

Subject: Relieving letter of student
Dear Sir,
Kindly refer your letter/e-mail dated ----------on the above cited subject. As permitted by your good self the following students will undergo Industrial OJT in your esteemed organization under your sole guidance and direction.

Sr. No.	Name	Roll no.	Year	Department

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned student mentor.

- OJT schedule may be prepared and a copy of the same may be sent to us.
- Each student is required to prepare OJT diary and report.
- Kindly check the OJT diary of the student daily.
- Issue instruction regarding working hours during training and maintenance of the attendance record

You are requested to evaluate the student's performance on the basis of grading i.e. Excellent, Very Good,

Satisfactory and Non-Satisfactory on the below mentioned factors:

- Attendance and general behavior
- Relation with workers and supervisors
- Initiative and efforts in learning
- Knowledge and skills improvement
- Contribution to the organization

The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.
Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated, and we shall feel obliged.
The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their OJT. The students will report to you on dated _____along with a copy of this letter.

Yours sincerely,

Nodal Officer/TPO
< HEI /college name and Date>

Appendix IV: B) Relieving Letter of Student (for part time OJT)

< HEI /college name Letter Head>

To,
The General Manager (HR) .....
.....

Subject: Relieving letter of student
Dear Sir,
Kindly refer your letter/e-mail dated ----------on the above cited subject. As permitted by your good self the following students will undergo Industrial OJT in your esteemed organization under your sole guidance and direction. The students will attend their OJT after completing their daily college work as part of their academic curriculum

Sr. No.	Name	Roll no.	Year	Department

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned student mentor.

- OJT schedule may be prepared and a copy of the same may be sent to us.
- Each student is required to prepare OJT diary and report.
- Kindly check the OJT diary of the student daily.
- Issue instruction regarding working hours during training and maintenance of the attendance record

You are requested to evaluate the student's performance on the basis of grading i.e. Excellent, Very Good, Satisfactory and Non-Satisfactory on the below mentioned factors:

- Attendance and general behavior
- Relation with workers and supervisors
- Initiative and efforts in learning
- Knowledge and skills improvement
- Contribution to the organization

The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.
Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated, and we shall feel obliged.
The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their OJT. The students will report to you on dated _____along with a copy of this letter.

Yours sincerely,

Nodal Officer/TPO
< HEI /college name and Date>

Appendix V: Relieving Letter of Student from organization

<Organization Letter Head>

To,
The Principal
[College Name]
[College Address]

Subject: Relieving Letter for Student

Dear Sir,

This is to certify that the following students from your esteemed institution have successfully completed their Industrial OJT in our organization as per the guidelines provided:

Sr. No.	Name	Roll no.	Year	Department

The students were under the supervision and guidance of our mentors and were engaged in various projects/tasks as part of their training. They have followed the rules and regulations of our organization and maintained a proper discipline throughout the OJT period.

Performance Evaluation:

The performance of the students has been evaluated based on the following criteria:

- Attendance and General Behavior
- Relation with Workers and Supervisors
- Initiative and Efforts in Learning
- Knowledge and Skills Improvement
- Contribution to the Organization

We have provided each student with feedback on their performance, which we hope will assist in their continued academic and professional growth. The detailed performance reports are enclosed in sealed envelopes for your reference.

We appreciate the opportunity to collaborate with your institution in providing practical exposure to the students and look forward to future engagements.

Yours sincerely,
[Signature]
[Name]
General Manager (HR)
[Company Name]
[Date]

Appendix VI: Student Diary (Log) Recording Format

Week (Dates during the week)	Task Assigned	Activities Performed	Key Learnings	Additional Remarks

Signature of Industry Supervisor

Appendix VII: Attendance Sheet

<Organization Letter Head>

Name & Address of Organization

_____
_____
_____

Name of the Student	
Roll Number	
Name of Course	
Date of Commencement of Training	
Date of Completion of Training	

Month and Year:

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

- Attendance Sheet should remain affixed in Daily Training Diary. Do not remove or tear it off.
- Holidays should be marked in Red Ink in attendance column. Absent should be marked as ‘A’ in Red Ink.

Name and Signature with date of OJT Supervisor _____

Appendix VIII: Supervisor Evaluation of Intern

<Organization Letter Head>

Student Name: _____ Date: _____

Work Supervisor: _____ Title: _____ Organization: _____

OJT Address: _____ Dates of OJT: From _____To _____

Please evaluate intern by indicating the frequency with which you observed the following behaviors:

Parameters	Needs Improvement	Satisfactory	Good	Excellent
1. Behaviors				
2. Performs in a dependable manner				
3. Cooperates with co-workers and supervisors				
4. Shows interest in work				
5. Learns quickly				
6. Shows initiative				
7. Produces high quality work				
8. Accepts responsibility				
9. Accepts criticism				
10. Demonstrates organizational skills				
11. Uses technical knowledge and expertise				
12. Shows good judgment				
13. Demonstrates creativity/originality				
14. Analyzes problems effectively				
15. Is self-reliant				
16. Communicates well				
17. Writes effectively				
18. Has a professional attitude				
19. Gives a professional appearance				
20. Is punctual				
21. Uses time effectively				

Overall performance of student intern (circle one):

(Needs improvement / Satisfactory / Good / Excellent)

Additional comments, if any: _____
Signature of Industry supervisor: _____
Manager: _____

Appendix IX: Student Feedback of OJT

(To be filled by Students after OJT completion)

Student Name: _____ Date: _____ Industrial Supervisor: _____Title: _____ Supervisor Email: _____OJT is: ____Paid ____Unpaid_____ Organization: _____ OJT Address:_____ Faculty Coordinator: _____Department: _____ Dates of OJT: From _____ To _____

Give a brief description of your OJT work (title and tasks for which you were responsible): Was your OJT experience related to your major area of study?

- Yes, to a large degree
- Yes, to a slight degree
- No, not related at all

Indicate the degree to which you agree or disagree with the following statements.

This experience has:	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
1. Given me the opportunity to explore a career field					
2. Allowed me to apply classroom theory to practice					
3. Helped me develop my decision-making and problem-solving skills					
4. Expanded my knowledge about the work world prior to permanent employment					
5. Helped me develop my written and oral communication skills					
6. Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)					
7. Expanded my sensitivity to the ethical implications of the work involved					
8. Made it possible for me to be more confident in new situations					
9. Given me a chance to improve my interpersonal skills					

10. Helped me learn to handle responsibility and use my time wisely					
11. Helped me discover new aspects of myself that I didn't know existed before					
12. Helped me develop new interests and abilities					
13. Helped me clarify my career goals					
14. Provided me with contacts which may lead to future employment					
15. Allowed me to acquire information and/ or use equipment not available at my Institute					

- In the Institute OJT program, faculty members are expected to be mentors for students. Do you feel that your faculty coordinator served such a function? Why or why not

- How well were you able to accomplish the initial goals, tasks and new skills that were set down in your learning contract? In what ways were you able to take a new direction or expand beyond your contract? Why were some goals not accomplished adequately?
- In what areas did you most develop and improve?
- What has been the most significant accomplishment or satisfying moment of your OJT?
- What did you dislike about the OJT?
- Considering your overall experience, how would you rate this OJT? (Circle one).
- -Satisfactory/ Good/ Excellent
- Give suggestions as to how your OJT experience could have been improved. (Could you have handled added responsibility? Would you have liked more discussions with your professor concerning your OJT? Was closer supervision needed? Was more of an orientation required?)

<Signature of Student>
<Name, Roll number, Date>

Appendix X: Performa for Evaluation of OJT by Institute

< HEI /college name Letter Head>

1. Name of Student: _____
2. Mob. No.: _____
3. Roll No.: _____
4. Branch/Semester: _____
5. Period of Training: _____
6. Home Address with contact No. _____
7. Address of Training Site: _____
8. Address of Training Providing Agency: _____
9. Name/Designation of Training In- charge: _____
10. Type of Work: _____

11. Date of Evaluation: _____
12. Please rate the following: _____

Overall Marks: _____.
Additional Remarks:_____.

Signature of Faculty Mentor: _____.

Course Duration:
Minimum **120 hours** of On Job Training with an Organization /Private firm.

- The theme of the OJT should be based on any study area of the Major course.
- Project Report should be of minimum 30 pages.
- Experience Certificate is Mandatory.

Evaluation Pattern

A. Continuous Internal Evaluation (40 marks)

Method	**Marks**
Presentation in the mid semester	**25**
Attendance and active participation at organization	**15**

B. Semester End Evaluation (60 marks)

Method	**Marks**
Project Report	**10**
Documentation and Presentation	**20**
Evaluation form by Employer	**30**

Name and Signature : Dr. Diwakar P. Karwanje.

Chairman of BOS of Mathematics