Shiv Chhatrapati Shikshan Sanstha's

# Rajarshi Shahu Mahavidyalaya, Latur

**(Autonomous)**


## Structure and Curriculum of Two Year Degree Programme

## Postgraduate Programme of Science and Technology

## M.Sc. in Mathematics

**Board of Studies in Mathematics**

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**w.e.f. June, 2023**

**(In Accordance with NEP-2020)**

**Academic Year : 2023-24**

## Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Mathematics** Programme to be effective from the **Academic Year 2023-24.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

**Date:** 09/08/2023

**Place:** Latur

**NEP Cell**

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

# CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc. Mathematics** Programme to be effective from the **Academic Year 2023-24.**

Date: 14/07/2023

Place: Latur

**Dr. M S Wavare**
Chairperson
Board of Studies in Mathematics
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Members of Board of Studies in the Subject Mathematics**

**Under the Faculty of Science and Technology**

**Department of Mathematics**

| Sr. No. | Name | Designation | In position |
|---|---|---|---|
| 1 | **Dr. Mahesh S Wavare**<br>Professor and Head, Department of Mathematics, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous) | Chairperson | HoD |
| 2 | **Dr. Bhalchandra D. Karande**<br>Head and Associate Professor, Department of Mathematics, Maharashtra Udaygiri Mahavidyalaya, Udaygiri Dist. Latur. | Member | V.C. Nominee |
| 3 | **Dr. S. D. Kendre**,<br>Associate Professor, Department of Mathematics, Savitribai Phule Pune University, Pune. | Member | Academic Council Nominee |
| 4 | **Dr. M. T. Gophane**<br>Associate Professor,Department of Mathematics Shivaji University, Kolhapur. | Member | Academic Council Nominee |
| 5 | **Dr. N. S. Darkunde**<br>School of Mathematical Sciences, S. R. T. M. U Nanded. | Member | Expert from outside for Special Course |
| 6 | **Mr. S. S. Ranmal**<br>Sungrace Computers Pvt Ltd, Pune. | Member | Expert from Industry |
| 7 | **Prof. S. M. Shinde**<br>Department of Mathematics, Government College of Engineering, Amravati, Dist. Amaravati. | Member | P.G. Alumni |
| 8 | **Dr. N. S. Pimple** | Member | Faculty Member |
| 9 | **Miss. S. D. Shinde** | Member | Faculty Member |
| 10 | **Mr. P. D. Bombalge** | Member | Faculty Member |
| 11 | **Mr. N. D. Kapale** | Member | Faculty Member |
| 12 | **Dr. A. A. Yadav** | Member | Member from the same faculty |

# From the Desk of the Chairperson…

When Shiv Chhatrapati Shikshan Sanstha started the Science Faculty in Rajarshi Shahu Mahavidyalaya, Latur in 1971, the Department of Mathematics was founded. In the beginning, there was just one instructor for the PUC class and the first year of the B.Sc. B.Sc.-II and B.Sc. III year courses began in 1973 and 1974, respectively, in response to the natural expansion. During the 2017–2018 academic year, the department launched its M.Sc. Mathematics programme with a 30-student entry limit.

The undergraduate degree course in mathematics is a six- or eight-semester course spanned across three- or four-academic years, in accordance with the guidelines of the Undergraduate Curriculum Framework 2022 (UGCF 2022). The teaching and learning process is centered on the learner and includes both theoretical and practical elements. While guaranteeing that the student has a solid foundation in the topic and obtains in-depth knowledge, it provides flexibility in program structure. A student may choose courses from the syllabus that includes Discipline Specific Electives (DSEs), Generic Electives (GEs), Skill Enhancement Courses (SECs), Ability Enhancement Courses (AECs), and Value Addition Courses (VACs) in addition to the Discipline Specific Core (DSC) courses. As a result, the interdisciplinary approach and commitment to creative approaches within the curricular framework are highlighted.

The new National Education Policy (NEP), 2020, which includes significant elements, offers a platform to develop, nurture, grow, encourage, and multiply mathematical thinking. To achieve a balance between the requirement for employment in the twenty-first century and entrepreneurship, which is characterized by lateral, critical, and numerical thinking, the essential changes have been put in place. The NEP acknowledged the importance of mathematical thinking and how necessary it is for the country to become a Vishwa guru. The NEP provides children with the nutrition they require by making mathematics enjoyable and engaging from the very beginning. Because it encourages the development of computer skills and intuitive reasoning, the NEP also requires the adoption of a coding curriculum, which should start in middle school.

The courses for the UG Programme are framed using time tested and internationally popular text books so that the courses are at par with the courses offered by any other reputed universities around the world.

Only those concepts that can be introduced at the UG level are selected and instead of cramming the course with too many ideas the stress is given in doing the selected concepts rigorously. The idea is to make learning mathematics meaningful and an enjoyable activity rather than acquiring manipulative skills and reducing the whole thing an exercise in using thumb rules.

As learning Mathematics is doing Mathematics, to this end, some activities are prescribed to increase student's participation in learning. Duration of the degree Programme shall be six- or-eight semesters distributed in a period of three/four academic years.

(Dr. Mahesh S Wavare)
Chairperson
Board of Studies in Mathematics

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

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Shiv Chhatrapati Shikshan Sanstha's

# Rajarshi Shahu Mahavidyalaya, Latur

**(Autonomous)**

**Department of Mathematics**

**PG Skeleton in Accordance with NEP-2020**

**Illustrative Credit Distribution Structure for Two Years M.Sc. Degree**

| Year Level | Sem | Major | | RM | OJT/FP | RP | Cum. Cr | Marks | Degree |
|---|---|---|---|---|---|---|---|---|---|
| | | **Mandatory** | **Elective** | RMC 4Cr | NA | NA | **20Cr** | | |
| **I 6.0** | **I** | MMC I 4Cr | MEC-I(A) OR MEC-I(B) 4Cr | | | | | Theory: 1Cr=25M | **PG Diploma (After 03 Year B.A. Degree)** |
| | | MMC II 4Cr | | | | | | | |
| | | MMC III 4Cr | | | | | | | |
| | **II** | MMC IV 4Cr | MEC-II(A) OR MEC-II(B) 4Cr | NA | OJT-I4Cr /FP-I 4Cr | NA | **20Cr** | OJT/FP: 1Cr=25M | |
| | | MMC V 4Cr | | | | | | | |
| | | MMC VI 4Cr | | | | | | | |
| | **Total** | **MMC 24Cr** | **MEC 08Cr** | **RMC 04Cr** | **OJT/FP 04Cr** | **NA** | **40Cr** | | |
| **II 6.5** | **III** | MMC VII 4Cr | MEC-III(A) OR MEC-III(B) 4Cr | NA | NA | RP-I 4Cr | **20Cr** | RPI & RPII: 1Cr=25M | **PG Degree (After 03 Year UG Degree)** |
| | | MMC VIII 4Cr | | | | | | | |
| | | MMC IX 4Cr | | | | | | | |
| | **IV** | MMC X 4Cr | MEC-IV(A) OR MEC-IV(B) 4Cr | NA | NA | RP-II 6Cr | **22Cr** | | |
| | | MMC XI 4Cr | | | | | | | |
| | | MMC XII 4Cr | | | | | | | |
| | **Total** | **MMC 24 Cr** | **MEC 08 Cr** | **NA** | **NA** | **RP 10 Cr** | **42Cr** | | |
| **Cum. Total of I & II Year** | | **MMC 48 Cr** | **MEC 16Cr** | **RMC 04Cr** | **OJT/FP 04Cr** | **RP 10Cr** | **40+42=82Cr** | | **82 Credits** |

**Abbreviations:**

1. MEC : Major Elective Course
2. RMC : Research Methodology Course
3. OJT : On Job Training (Internship/Apprenticeship)
4. FP : Field Project
5. RP : Research Project
6. Cum. Cr : Cumulative Credit

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**M.Sc. Mathematics Skeleton in Accordance with NEP-2020**

**Illustrative Credit Distribution Structure for Two Years/One Year PG (M.Sc.)**

| Year & Level | Semester | Course Code | Course Title | Credits | No. of Hrs. |
|---|---|---|---|---|---|
| I<br>6.0 | I | 601MAT1101<br>MMC-I | Group Theory | 04 | 60 |
| | | 601MAT1102<br>MMC-II | Real Analysis | 04 | 60 |
| | | 601MAT1103<br>MMC-III | Complex Analysis | 04 | 60 |
| | | 601MAT1201<br>MEC-I (A)<br>OR<br>MEC-I (B) | Ordinary Differential Equation<br><br>OR<br>Theory of Probability | 04 | 60 |
| | | 601MAT1301<br>(RMC) | Research Methodology | 04 | 60 |
| | **Total Credits** | | | **20** | |
| | II | 601MAT2101<br>MMC-IV | Linear Algebra | 04 | 60 |
| | | 601MAT2102<br>MMC-V | Topology | 04 | 60 |
| | | 601MAT2103<br>MMC-VI | Analytical Number Theory | 04 | 60 |
| | | 601MAT2201<br>MEC-II (A)<br>601MAT2202 | Partial Differential equation<br>OR<br>Measure and Integration | 04 | 60 |
| | | Field Project<br>(FP)<br>601MAT2401 | FP-I : **Field Project** | 04 | 60 |
| | **Total Credits** | | | **20** | |
| **Total Credits (Semester I & II)** | | | | **40** | |

| **Programme Outcomes (POs) for M.Sc. Programme** | |
|---|---|
| PO No. | Upon completion of this Programme the students will be able to |
| PO 1 | To Develop their mathematical knowledge, oral, written, and practical skills in a way to enhance confidence and provide satisfaction. |
| PO 2 | To inculcate the confidence by developing a feel for numbers, patterns, and relationships. |
| PO 3 | To advance an ability to consider, solve problems, present and interpret results. |
| PO 4 | To improve Communication and reason using mathematical concepts. |
| PO 5 | To understand mathematical principles and their applications. |
| PO 6 | To foster the abilities to reason logically, to classify, to generalize and to prove. |
| PO 7 | To acquire the foundation, appropriate to their further studies of mathematics and of other disciplines. |
| PO 8 | To do research project in the field of Mathematics. |

| **Programme Specific Outcomes (PSOs) for M.Sc. in Mathematics** | |
|---|---|
| PSO No. | Upon completion of this programme, the students will be able to |
| PSO 1 | Upgrade the knowledge to qualify CSIR-NET/SET/GATE in Mathematical Sciences. |
| PSO 2 | Get tune with further studies of their area of interest. |
| PSO 3 | Be good teacher in Mathematics subject. |
| PSO 4 | Get placed in job of Scientific Computing /Data Analyst etc . |
| PSO 5 | Comprehend and write effective reports and design documentation related to mathematical research and literature, make effective presentations. |
| PSO 6 | Implant in students' inventive qualities, teamwork, and ethical practices in order to achieve society standards. |
| PSO 7 | Provide a high-quality education by incorporating projects, participatory learning, and cutting-edge software tools into successful teaching and learning processes. |
| PSO 8 | Provide a comprehensive curriculum which will educate students towards becoming great scientific professionals. |
| PSO 9 | Inculcate the interest for mathematics in students and to prepare them for potential research. |
| PSO 10 | Promote collaborative learning and application of mathematics to real life situation. |

# Semester - I

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-I**

**Course Title: Group Theory**

**Course Code: 601MAT1101**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

LO 1. To study basic group theory, Action on group

LO 2. To study Caley theorem

LO 3. To study Fundamental Theorems of Finite Abelian group

LO 4. To study Sylow's theorem

**Course Outcomes:**

After completion of the course, students will be able to

CO 1. Apply Action mapping and fundamental theorems of homomorphism

CO 2. Solve examples on internal and external direct product .

CO 3. Solve examples on Sylows Theorem

CO 4. Relate abstract algebraic constructs to more familiar number sets and operations and see from where the constructs derive. Identify examples of specific constructs.

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Groups and Homomorphism of groups** | **15** |
| | 1. Groups, semi groups and groups<br>2. Homomorphism, Subgroups and cosets, Cyclic groups, Generators and relations,<br>3. Normal subgroup and quotient group | |
| | **Unit Outcomes:**<br>UO 1. Acquaint with the basic concepts of mathematics such as group , homomorphism.<br>UO 2. Able to find structures of different groups. | |
| **II** | **Isomorphism of groups** | **15** |
| | 1. Isomorphism theorems, Automorphism<br>2. Conjugacy and *G*-sets, Normal series | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | 3. Solvable groups, Nilpotent groups | |
| | **Unit Outcome:**<br>UO 1. Can relate isomorphism of groups. | |
| **III** | **Homomorphism and Isomorphism** | **15** |
| | **1.** Group Homomorphism, First Isomorphism Theorem, Fundamental Theorem of Finite Abelian Groups, Permutation Groups, Cyclic decomposition, Alternating group $A_n$ | |
| | **Unit Outcomes**:<br>UO 1. One can Apply isomorphism theorems to find structure of groups. | |
| **IV** | **Direct Product and Sylow theorems** | **15** |
| | 1. Structure of groups, Direct product, Finitely Generated Abelian Groups, Invariants of a finite abelian group<br>2. Sylow Theorems and its applications | |
| | **Unit Outcomes**:<br>UO 1. One can Apply Sylow theorem. | |

**Learning Resources:**


1. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic AbstractAlgebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995)
2. Joseph A. Gallian, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.
3. I. S. Luthar and I. B. S. Passi, "Algebra-Vol. 1: Groups", Narosa, NewDelhi, 1996.
4. V.K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publishing House.(Second Edition)
5. David Dummit and Richard Foote, "Abstract Algebra", John Wiley and Sons

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-II**

**Course Title: Real Analysis**

**Course Code: 601MAT1102**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives**

LO 1. To study the concept of limit of sequences of functions and function of several variables.

LO 2. To find, disc of convergence, radius of convergence of power series and its applications.

LO 3. To compute derivatives and integrals of higher dimensional functions.

LO 4. To Study Stokes and Gauss Divergence Theorem

**Course outcomes**

After completion of course the student will be able to-

CO 1. Analyze any type of sequence or series

CO 2. Check differentiability and find total derivative and directional derivatives

CO 3. Find line integral, surface integral mainly using fubini's theorem

CO 4. Apply Stokes and Gauss Divergence Theorem

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Pointwise and Uniform Convergence** | **12** |
| | 1. Pointwise convergence of sequences of functions, Examples of sequences of real valued functions<br>2. Definition of uniform convergence, Uniform convergence and continuity, Cauchy condition for uniform convergence<br>3. Uniform convergence and Riemann integration, Uniform convergence and differentiation, Equicontinuous family of functions | |
| | **Unit Outcome**:<br>UO 1. Able to check convergence of sequence.<br>UO 2. Able to solve the problems based on pointwise and uniform convergence. | |
| **II** | **Directional Derivatives** | **10** |
| | 1. The Directional derivatives, directional derivatives and continuity, total derivative, total derivatives expressed in terms of partial derivatives | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | 2. 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 $R$. | |
| | **Unit Outcome**:<br>UO 1. To Determine Directional derivative of functions. | |
| **III** | **Function of severable variables** | **10** |
| | 1. Functions of several variables, Linear transformation<br>2. Differentiation, Contraction principle, The inverse function theorem, The implicit function theorem and their applications | |
| | **Unit Outcomes**:<br>UO 1. To know more about function of several variables | |
| **IV** | **Integral calculus** | **10** |
| | 1. Integral Calculus: Path and line integrals, Multiple integrals Double integral (Theorems without proof) Application to area and volume. (Theorems without proof)<br>2. Greens theorem in the plane. Application of Green's Theorem. Necessary condition for a vector field to be gradient. Length of the curve.<br>3. Change of variables, special cases of transformation formula. Surface integral, change of parametric representation. Other notations for surface integrals, Stoke's Theorem Curl and divergence of a Vector field. Gauss divergence Theorem. | |
| | **Unit Outcome:**<br>UO 1. To study multiple integral and its applications | |

**Learning Resources:**


1) Principles of mathematical Analysis, Walter Rudin, third Edition, McGraw Hill book company
2) Mathematical Analysis, Apostal, Second Edition, Narosa Publishing House.
3) Calculus Vol. II , Tom M. Apostol, Second Edition Wiley India Pvt. Ltd
4) W.Fleming, Functions of several Variables,2nd Edition ,Springer Verlag, 1977.
5) J.R.Munkres, Analysis on Manifolds 4. Calculus, Schaum's outline series , Ayres F, Sixth Edition, Mc Graw Hill, (2013).

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-III**

**Course Title: Complex Analysis**

**Course Code: 601MAT1103**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

LO 1. To study Complex Field, Algebra of complex numbers.

LO 2. To study Stereographic Projection, Transformation & Mapping Properties.

LO 3. To Discuss Analyticity, Harmonic Functions

LO 4. To evaluate Line Integrals using Cauchy's Theorems

LO 5. To Compute Singularities and Classify it

**Course Outcomes:**

After completion of course the student will be able to-

CO 1. Understand how complex numbers provide a satisfying extension of the real numbers

CO 2. Describe and parameterize curves and regions in two-dimensional space.

CO 3. Appreciate how throwing problems into a more general context may enlighten one about a specific context.

CO 4. Learn techniques of complex analysis that make practical problems easy

CO 5. know the condition(s) for a complex variable function to be analytic and/or harmonic.

CO 6. Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula.

CO 7. Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line.

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Complex Field and Mappings** | **15** |
| | 1. Complex Field, Modulus, Argument and Conjugate of complex numbers, Algebra of complex numbers<br>2. Rectangular and Polar representation of Complex numbers, Point sets in the plane, Sequences. Stereographic Projection, Linear Fractional, Transformation, Other Mappings, The Exponential Function, Mapping Properties | |
| | **Unit Outcomes:**<br>UO 1. Understand how complex numbers provide a satisfying extension of the real numbers | |
| **II** | **Analyticity and Power Series** | **15** |
| | 1. The Logarithmic Function, Complex Exponents, Power series, Analytic functions, Analyticity, Harmonic Functions,<br>2. Sequences of Functions, Uniform Convergence, Maclaurin and Taylor Series, Operations on Power series. Taylor's Theorem, Cauchy's Estimate, Zeros of an analytic function, Louville's Theorem, Fundamental Theorem of Algebra, Maximum Modulus Theorem. | |
| | **Unit Outcome:**<br>UO 1. Appreciate how throwing problems into a more general context may enlighten one about a specific context | |
| **III** | **Line Integrals** | **15** |
| | **1.** Curves , Parameterizations, Line Integrals, Cauchy's Theorems. Index of a closed curve, Cauchy's Theorem, Cauchy's Integral Formula, Morera's Theorem.<br>**2.** The Homotopic version of Cauchy's Theorem and simple connectivity, Counting of Zeros, The Open mapping Theorem, Goursat's theorem | |
| | **Unit Outcome**:<br>UO 1. Learn techniques of complex analysis that make practical problems easy | |
| **IV** | **Direct Product and Sylow theorems** | **15** |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | 1. Singularities, Classification of Singularities, Laurent's Series, Casorati-Weierstrass Theorem, Residues, Cauchy's Residue Theorem, Evaluation of Integrals, Meromorphic functions<br>2. The Argument Principle, Rouche' Theorem, Schwartz Lemma. Convex Functions and Hadamard's three Circles Theorem, The Riemann mapping Theorem | |
| | **Unit Outcome**:<br>UO 1. Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line. | |

**Learning Resources:**


1. S. Ponnusamy and Herb Silverman, "Complex Variables with Applications", Birkhauser Publication.
2. Silverman Herb, "Complex Analysis",
3. John B. Convey, "Function of one complex variable", Narosa Pub. House , 1980.
4. Lars V. Ahlofors, "Complex Analysis", McGraw Hill Co.
5. S. Ponnusamy, " Foundations of Complex Analysis", Narosa Publishing House.

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MEC-I**

**Course Title: Ordinary Differential Equations**

**Course Code: 601MAT1201**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

LO 1. Learn to solve first-order differential equations.

LO 2. Learn to solve linear differential equations of higher-order.

LO 3. Learn to solve a second-order differential equation with constant coefficients.

LO 4. Learn to solve differential equations with variable coefficients

LO 5. Learn to check existence and uniqueness of solutions to first order differential equations

**Course Outcomes:**

After completion of course the student will be able to-

CO 1. Recognize definition and properties of initial value problems

CO 2. Recognize definition and properties of linear dependence and independence, Wronskian, singular points, regular singular points, Lipschitz constant

CO 3. Apply power series solution method, method of successive approximation

CO 4. Recognize properties of Eular equation and Bessel equation, non – local existence of solutions.

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Linear Differential equation** | **15** |
| | 1. Linear equations of first order, Initial Value Problem for<br>2. second order equations Initial value problems, Solutions of the homogeneous equation | |
| | **Unit Outcomes:**<br>UO 1. Recognize Linear and non linear Differential equations.<br>UO 2. Able to solve initial value problems | |
| **II** | **Non-homogeneous Differential Equation** | **15** |
| | 1. Linear dependence and independence, A formula for the Wronskian.<br>2. The non-homogeneous equations of order two, The homogeneous equations of order n, Initial Value Problem for nth order equations. | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | **3.** Equations with real constants, The non-homogeneous equations of order-n, A special method for solving the non-homogeneous equation, Algebra of constant coefficient operators. | |
| | **Unit Outcome:**<br>UO 1. Able to solve non-homogeneous Differential equations. | |
| **III** | **Linear Differential equations with Regular Singular Points** | **15** |
| | 1. Wronskian and linear independence, Reduction of order, Non-homogeneous equations.<br>2. Legendre equation, Linear Equations with regular singular points: Euler equation, Second order equation with regular singular points, Exceptional cases.<br>3. The Bessel equation, The Bessel equation (Continued). | |
| | **Unit Outcomes**:<br>UO 1. Recognize properties of Eular equation and Bessel equation, non – local existence of solutions. | |
| **IV** | **Linear Differential equations with successive approximations** | **15** |
| | 1. Separation of variables, Exact equations, Method of successive approximations<br>2. Lipchitz condition, Convergence of the successive approximations, Non local existence of solutions, Approximations to, and uniqueness of solutions, Equations with complex valued functions. | |
| | **Unit Outcomes**:<br>UO 1. Apply power series solution method, method of successive approximation | |

**Learning Resources:**

1. E.A. Codington, "An Introduction to Ordinary Differential Equations",(Prentice- Hall).
2. G. F. Simmons and S. G. Krantz, "Differential Equations", (Tata Mc Graw-Hill ).
3. Daniel A. Murray, "Introductory Course in Differential Equation",Universities Press.

**Shiv Chhatrapati Shikshan Sanstha's**

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MEC-I**

**Course Title: Theory of Probability**

**Course Code: 601MAT1201**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

LO1: To acquire knowledge Elementary theory of probability.

LO2: To differentiate discrete and continuous random variable.

LO3: To study Discrete probability distribution.

LO4: To study Normal Distributions.

**Course outcomes**

After completion of the course, students will be able to-

CO1: Solve examples on Bays Theorem

CO2: Differentiate continuous and discrete random variable

CO3: Learn some discrete probability distributions

CO:4 Learn Normal probability distributions

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Introduction to Probability** | **15** |
| | 1. Basic Definitions, Mathematical and statistical probability, Subjective Probability.<br>2. Axiomatic approach to probability, Theorems on probability, Conditional probability,<br>3. Multiplication theorem of probability of independent events, Examples, Extended axiom of axiom of addition and axiom of continuity.<br>4. Baye's theorem. | |
| | **Unit Outcome**:<br>UO1: To study Axiomatic approach of Probabilty and some results on it. | |
| **II** | **Random Variables** | **20** |
| | 1. Random variables, Types , Probability function of discrete random variable.<br>2. Continuous random variable, Probability density function. | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | 3. Mathematical expectation, Properties of expectation.<br>4. Variance, Properties of Variance.<br>5. Moment generating function, Properties of Moment generating function, Cumulants and its properties. | |
| | **Unit Outcomes**:<br>UO1: To study discrete and continuous random variables<br>UO2: To study mathematical expectation and variance of random variable | |
| **III** | **Discrete Probability distributions** | **13** |
| | 1. Binomial distribution, Mean and Variance of binomial distribution, MGF and CGF of Binomial distribution.<br>2. Fitting of binomial distribution,<br>3. Poisson distribution, Mean and variance of Poisson distribution, MGF and CGF of Poisson distribution,<br>4. Fitting of Poisson distribution, | |
| | **Unit Outcomes**:<br>UO1: To compute mean and variance of Binomial and Poisson random variable<br>UO2: To Compute MGF and CGF of Binomial and Poisson Distributions | |
| **IV** | **Normal Distribution** | **12** |
| | 1. Normal distribution, Properties of normal distribution.<br>2. Moments of normal distribution,<br>3. MGF and CGF and fitting of normal distribution. | |
| | **Unit Outcome:**<br>UO1: To compute MGF and CGF of Normal distribution | |

**Learning Resources:**


1. Ronald E. Walpole, Raymond H Myers, "Probability and Statistics for Engineers and Scientist" Fourth Edition.
2. S .C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi.
3. S.C. Gupta, V.K. Kapur, "Fundamental of Mathematical Statistics",S. Chand and Co. Ltd.
4. S. C. Saxena, "Mathematical Statistics", S. Chand and Co. Ltd.

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: RMC**

**Course Title: Research Methodology**

**Course Code: 601MAT1301**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

LO1. To enable to student to understand and work methods and concepts related Research.

LO2. To enable the student to develop research proposal and to work with research problem.

LO3. To develop broad comprehension of research area.

**Course Outcomes:**

After completion of the course, students will be able to-

CO1. Examine the basic aspects of Research methods

CO2. Apply and integrate the basic concepts Collection and analysis of data.

CO3. Know the of report writing and evaluation methods.

CO4. Examine the plagiarism by using various apps.

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Introduction and Methods of Research** | **15** |
| | 1. Meaning of Research, Objectives of Research, Types of Research,<br>2. Research Approaches, Significance of Research, Research Methods Versus Methodology, Research and Scientific Methods,<br>3. Research Processes, Criteria for Good Research<br>4. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques Involved in Defining a Problem | |
| | **Unit Outcome:**<br>UO1. Examine the basic aspects of Research methods | |
| **II** | **Research Design and Sampling** | **15** |
| | 1. Meaning and Need for Research Design, Features of A Good Design.<br>2. Important Concepts Relating to Research Design: Dependent and Independent Variables, Extraneous Variables, Control, Research Hypothesis, Experimental and Non-Experimental Hypothesis –Testing Research, Experimental and Control Group | |

| | | |
|---|---|---|
| | 3. Different Research Designs: Research Design in Case of Exploratory Research Studies, Research Design in Case of Hypothesis- Testing Research Studies, Basic Principles of Experimental Designs, Important Experimental Designs<br>4. Sampling Design, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of A Good Sample Design, Different Types of Sample Design | |
| | **Unit Outcome:**<br>UO1. Apply and integrate the basic concepts Collection and analysis of data. | |
| **III** | **Data Collection and Data Processing** | **15** |
| | 1. Measurements in Research, Measurement Scales, Sources of Errors in Measurement.<br>2. Collection of Primary Data: Observation Method, Interview Method, Through Questionnaires, Through Schedules, Difference Between Questionnaire and Schedule<br>3. Collection of Secondary Data, Selection of Appropriate Methods for Data Collection, Case Study Method<br>4. Data Processing, Processing Operations: Editing, Coding, Classification, Tabulation, Graphical Representation, Types of Analysis, Statistical Tools and Techniques Of Data Analysis-Measures Of Central Tendency, Dispersion. | |
| | **Unit Outcome**:<br>UO1. Know the of report writing and evaluation methods | |
| **IV** | **Report Writing and Evaluations** | **15** |
| | 1. Principles of Report Writing and Guide Lines According to Style Manuals.<br>2. Writing and Presentation of Preliminary, Main Body and Reference Section of Report.<br>3. Evaluation of Research Report.<br>4. Methods to Search Required Information Effectively, Reference Management Software Like Zotero/ Mendeley, Software for Paper Formatting Like Latex/ MS Office.<br>5. Software for Detection of Plagiarism. | |
| | **Unit Outcome**:<br>UO1. Examine the plagiarism by using various apps. | |

**Learning Recourses: -**


1. Bajpai S. R. (1975) Methods of Social Survey and Research, Kitabghar, Kanpur.
2. Hans Raj (1988) Theory and Practice in Social Research, Surjeet Publication, Kolhapur.
3. Krishnaswami O. R. (1988) Methodology of Research in Social Science, Himalaya Pub. House.
4. Sadhu, Singh, Research Methodology in Social Science Bhandarkar, Research Methodology
5. Kothari, C. R. (2005) Quantitative Technique, New Delhi, Vikas Publication House.
6. Gautam, N. C. (2004) Development of Research tools, New Delhi, Shree Publishers.
7. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
8. Chandera A. and Sexena T. P. (2000) Style Manual, New Delhi, Metropolitan Book Comp. Ltd.
9. Shukla, J. J. (1999) Theories of Knowledge, Ahmadabad, Karnavati Publication.
10. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.
11. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
12. Best J. W. and Khan J. V. (2005) Research in Education New Delhi, Prentice Hall India.

# Semester - II

**Shiv Chhatrapati Shikshan Sanstha's**

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-IV**

**Course Title: Linear Algebra**

**Course Code: 601MAT2101**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives**

LO 1. To Study Basic linear algebra

LO 2. To acquire knowledge of Linear transformation

LO 3. To study Computational Linear Algebra

LO 4. To Study Inner product space

**Course outcomes**

After completion of course the student will be able to-

CO 1. Find Dimension of vector space

CO 2. Decide regularity of linear maps

CO 3. Apply Caley Hamilton theorem

CO 4. Find Jordan Canonical form of given matrix if exists

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Introduction To Vector Spaces** | **15** |
| | 1. Introduction, Vector spaces, subspaces, Quotient Spaces<br>2. Linear combinations and system of linear equations<br>3. linear dependence and independence<br>4. Bases and dimension, Maximal Linear Independent Subsets. | |
| | **Unit Outcome**:<br>UO 1. To acquire knowledge about different vector spaces, its bases and dimension. | |
| **II** | **Linear Transformation** | **15** |
| | 1.Linear Transformations, Null spaces, Range spaces<br>2.The matrix representation of a linear transformation, Composition of linear transformations<br>3.Invertibility and Isomorphism, The change of Co-ordinate matrix, Dual spaces. | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | **Unit Outcomes**:<br>UO 1. To study linear transformation<br>UO 2. Apply the knowledge of linear transformation to check isomorphism of vector spaces. | |
| **III** | **Matrix Operation And System of Linear Equation** | **15** |
| | 1.Elementary Matrix Operations and elementary matrices, The rank of a matrix<br>2.System of linear Equations-Theoretical Aspects, System of linear equations-Computational Aspects<br>3.Eigen values and Eigen vectors, Diagonalizability, Triangulable Operators<br>4. Invariant Subspaces, Cayley-Hamilton Theorem. | |
| | **Unit Outcomes**:<br>UO 1. To study different aspects of system of linear equations.<br>UO2. To acquire knowledge about eigen spaces and diagonalizability. | |
| **IV** | **Inner Products and Norms** | **15** |
| | 1. Inner products and Norm<br>2. The Gram-Schmidt Orthogonalization process and orthogonal complements<br>3. The adjoint of a linear operator, Bilinear forms, Quadratic forms.<br>4.Jordan Canonical form-I, Jordan Canonical form-II, The Minimal Polynomial, Rational Canonical form. | |
| | **Unit Outcome:**<br>UO 1. To Study Inner product space<br>UO 2. To Find Jordan Canonical form of given matrix if exists. | |

**Learning Resources:**


1. S.H. Friedberg, A.J. Insel, L.E. Spence, "Linear Algebra", Prentice-Hall, International, Inc., 3rd Edition.
2. Vivek Sahai and Vikas Bist, "Linear Algebra", Narosa Publishing House,2nd Edition.
3. S. Lang, "Introduction to Linear algebra", Springer International Edition,2nd Edition.
4. K.Hoffman, R.Kunze, "Linear Algebra", Prentice Hall of India.
5. S.Kumaresan, "Geometrical approach to Linear Algebra"

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-V**

**Course Title: Topology**

**Course Code: 601MAT2102**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives**

LO 1. Equivalence set, countable sets and their examples

LO 2. Topology, Topological spaces, basis for a topology

LO 3. Continuous functions, compactness, connectedness, uniform continuity

LO 4. T1, T2, T3 and T4 spaces

**Course outcomes**

After completion of course the student will be able to-

CO 1. Find cardinality of any set.

CO 2. Check continuity and apply properties of continuous function

CO 3. Apply all properties of compactness, connectedness, separation axioms, countability axioms.

CO 4. Understand various Topological Spaces.

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Countability of Sets** | **15** |
| | 1. Cartesian Products, Finite Sets<br>2. Countable and Uncountable Sets<br>3. Infinite Sets and Axiom of Choice, Well Ordered Sets. | |
| | **Unit Outcome**:<br>UO 1. To study the basic set theory. | |
| **II** | **Introduction to Topology** | **15** |
| | 1. Basis for a topology, Order topology<br>2. Subspace Topology, Product topology<br>3.Closed sets and limit points, Continuous functions, Metric Topology. | |
| | **Unit Outcome**: | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | UO 1. To acquire knowledge about basics of Topology. | |
| **III** | **Connectedness and compactness** | **15** |
| | 1. Connected spaces, Connected Subspaces of Real Line<br>2. Components and Local Connectedness<br>3. Compact spaces, Compact Subspaces of the Real Line<br>4. Limit point compactness, Local Compactness. | |
| | **Unit Outcomes**:<br>UO 1. To study Continuous functions, compactness, connectedness, uniform continuity. | |
| **IV** | **Separation Axioms** | **15** |
| | 1. Countability Axioms, Separation axioms<br>2. Normal Spaces, Urysohn's Lemma, Tietze Extension Theorem 3. Metrization Theorem, Tychonoff's Theorem. | |
| | **Unit Outcome:**<br>UO 1. To study T1, T2, T3 and T4 spaces | |

**Learning Resources:**


1. J.R. Munkres, "Topology" Prentice Hall of India, Second Edition.
2. Stephen Willard, "General Topology", Addison-Wesley Publishing Company, 1970
3. J. Dugundji Topology, Allya and Bacon. (1966) reprinted: Prentice Hall of India.
4. W. J. Pervin, Foundations of general topology, academic press Inc. N.Y. H
5. S. T. Hu, Elements of general topology. Holden day Inc. 1965.

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MMC-VI**

**Course Title: Analytical Number Theory**

**Course Code: 601MAT2103**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives:**

**LO1:** To study Theory of Congruence's and applications.

**LO2:** To study Number Theoretic Function

**LO3:** To study Phi Function and its Properties

**LO4:** To discuss Primitive roots for primes

**Course outcomes**

After completion of course the student will be able to-

**CO1:** Solve Linear Congruence's and apply Chinese Remainder Theorem

**CO2:** Compute sum and number of divisors

**CO3:** Discuss Euler Phi Function and its properties

**CO:4 Use $\psi(n), \tau(n)$**

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Theory of Congruence's and Fermat's Theorem** | **15** |
| | 1.Carl Friedrich Gauss<br>2.Basic properties of congruence's, Binary and decimal representation of integers, Linear congruence's and Chinese Remainder theorem.<br>3.Pierre de Fermat theorem, Fermat's little theorem and pseudo primes, Wilson's theorem. | |
| | **Unit Outcome**:<br>UO1: To Study linear congruence's and applications | |
| **II** | **Number theoretic Functions** | **15** |
| | 1.The sum and Number of divisors<br>2. The Mobius inversion formula<br>3. The greatest integer function<br>4. The application to the calendar | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | **Unit Outcome**:<br>UO1: To apply Number Theoretic Functions | |
| **III** | **Euler's Generalization of Fermat's Theorem** | **15** |
| | 1.Leonhard Euler<br>2. Euler's phi function<br>3. Euler's theorem<br>4. Some properties of phi function | |
| | **Unit Outcomes**:<br>UO1: To study Properties of Phi function | |
| **IV** | **Primitive roots and indices** | **15** |
| | 1.The order of an integer modulo n<br>2. Primitive roots for primes<br>3. Composite numbers having primitive roots<br>4. The theory of indices | |
| | **Unit Outcome:**<br>UO1: To study composite numbers having prime roots | |

**Learning Resources:**


1. David M. Burton, "Elementary Number Theory" Tata McGraw-Hill Pub. VI Edition.
2. Tom M. Apostol, "Introduction to Analytic number theory" Narosa Publishing house 1980.
3. J.P. Serre, "A course in arithmetic" GTM Vol.7, Springer Verlage 1973
4. Kenneth Ireland and Michael Rosen, "A Classical Introduction to Modern Number Theory" Second Edition Springer

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MEC-II**

**Course Title: Partial Differential equation**

**Course Code: 601MAT2201**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives**

LO 1. To introduce students to partial differential equations

LO 2. To solve linear Partial Differential with different method

LO 3. Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes among many other scenarios.

LO 4. To present the main results in the context of partial differential equations that allow learning about these models.

**Course outcomes**

After completion of course students will be able to-

CO 1. Classify partial differential equations and transform into canonical form;

CO 2. Recognize the linear and non-linear partial differential equations of both first and second order by using elementary methods.

CO 3. Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.

CO 4. Recognize real problems by identifying them appropriately from the perspective of partial derivative equations

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Introduction to PDE** | **15** |
| | 1.Introduction, Linear Equation of first order, Charpit's Method, Jacobi's Method<br>2.Quasi-Linear Equations, Non-Linear First Order P.D.E<br>3.General solution of higher order PDE's with constant coefficients<br>4.Special Functions - Bessel's function, Legendre's function. | |
| | **Unit Outcome**: | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | UO 1. To identify linear, quasi linear and non-linear PDEs<br>UO 2.To acquire knowledge about some special functions like Bessel's function, Legendre function, etc. | |
| **II** | **Second order PDE** | **15** |
| | 1.Introduction, Method of separation of variables<br>2.Classification of Second order PDE, One Dimensional Wave Equation<br>3. Laplace Equation, Boundary Value Problems, the Cauchy's Problem, | |
| | **Unit Outcome**:<br>UO 2. To acquire knowledge about different solving techniques of PDE | |
| **III** | **Some special problems in PDE** | **15** |
| | 1.Dirichlet and Neumann Problem for different regions<br>2. Harnack's Theorem, Heat Conduction Problem, Duhamel's Principle | |
| | Unit Outcomes:<br>UO 1. To study Dirichlet and Neumann problems for different regions. | |
| **IV** | **Families of Surfaces and inversion theorem** | **15** |
| | 1. Classification of P.D.E. in the case of n-variables<br>2. Families of Equipotential Surfaces, Kelvin's Inversion Theorem. | |
| | **Unit Outcome:**<br>UO 1. To study Kelvin's Inversion theorem. | |

**Learning Resources:**


1. T. Amarnath, "An Elementary Course in Partial Differential Equations", (2nd edition), (Narosa Publishing House) [Chapters 1 & 2].
2. I.N. Sneddon, "Elements of partial differential equations", (Mc-GrawHill Book Company).
3. K. Sankara Rao, "Introduction to partial differential equation", 3rdedition.
4. W. E. Williams, "Partial Differential equations", (Clarendon press oxford)
5. E. T. Copson, "Partial differential equations", (Cambridge university press).
6. H.K. Dass, "Advanced Engineering Mathematics", S. Chand & Co. Ltd

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Department of Mathematics**

**Course Type: MEC-II**

**Course Title: Measure and Integration Theory**

**Course Code: 601MAT2202**

**Credits: 04** **Max. Marks: 100** **Lectures: 60 Hrs.**

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**Learning Objectives**

LO 1. Different type of measures and integration.

LO 2. Relation between derivatives and integration

LO 3. Generalization of measure on different abstract spaces

LO 4. Signed measure and its properties

**Course outcomes**

After completion of course students will be able to-

CO 1. Know and understand the concept of a sigma-algebra and a measure.

CO 2. Know and understand the concept of the Lebesgue measure.

CO 3. Know and understand the concept of almost everywhere prevailing properties

CO 4. Understand the Radon-Nikodym theorem

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| **I** | **Measurable sets, Measurable functions** | **15** |
| | 1. Lebesgue outer measure, Measurable sets, Measurable functions.<br>2.Borel and Lebesgue measurability.<br>3.Integration of non-negative functions, The general integral, Integration of series.Riemann and Lebesgue Integrals.<br>4. The four derivatives, Continuous non-differentiable functions.<br>5.Functions of bounded variations, Differentiation and integration | |
| | **Unit Outcome**:<br>UO 1. To acquire knowledge about different types of measure integrals. | |
| **II** | **Abstract measure spaces** | **15** |
| | 1. Abstract measure spaces: Measure and outer measure.<br>2. Extension of measure, Uniqueness of the extension.<br>3. Completion of measure, Measure spaces.<br>**4.** Integration with respect to measure. | |

| Unit No. | Title of Unit & Contents | Hrs. |
|---|---|---|
| | **Unit Outcome**:<br>UO 1. To familiarize with the various types of measure spaces. | |
| **III** | **Signed measure and their derivatives** | **15** |
| | 1. Signed measure and their derivatives: Signed measure and the Hahn-Decomposition.<br>2. The Jordan decomposition.<br>3. The Raydon–Nikodym theorem(Statement only) | |
| | **Unit Outcome:**<br>UO 1. To understand signed measure and the Jordan decomposition. | |
| **IV** | **Measure and integration in a product spaces** | **15** |
| | 1. Measure and integration in a product spaces: Measurability in a product spaces.<br>2. The product measure and Fubini's theorem.<br>3. Lebesgue measure in Euclidean space | |
| | **Unit Outcomes:**<br>UO 1. To Know and understand products measures and Fubini's theorem.<br>UO 2. To understand the relation between convergence of Lebesgue integrals and pointwise convergence of functions | |

**Learning Resources:**


1.G.de Barra, "Measure theory and integration", New Age International(P) Ltd. Publishers.

2.P.K. Jain and V.P. Gupta, "Lebesgue measure and Integration" New Age International (P) Ltd. Publishers.

3.P.R. Halmos, "Measure theory", Van Mostranel Princeton, 1950.

4.Inder K. Rana, "An introduction to measure and Integration", Narosa Publishing House, Delhi,1997.

Shiv Chhatrapati Shikshan Sanstha's

# Rajarshi Shahu Mahavidyalaya, Latur

**(Autonomous)**

**PG First Year**

## Extra Credit Activities

| Sr. No. | Course Title | Credits | Hours T/P |
|---|---|---|---|
| 1 | MOOCs | Min. of 02 credits | Min. of 30 Hrs. |
| 2 | Certificate Courses | Min. of 02 credits | Min. of 30 Hrs. |
| 3 | IIT Spoken Tutorial Courses | Min. of 02 credits | Min. of 30 Hrs. |

**Guidelines:**

**Extra -academic activities**

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

**Additional Credits for Online Courses:**

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

**Additional Credits for Other Academic Activities:**

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

**Additional Credits for Certificate Courses:**

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

**Note:**

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.

Shiv Chhatrapati Shikshan Sanstha's

**Rajarshi Shahu Mahavidyalaya, Latur**

**(Autonomous)**

**Examination Framework**

**Theory:**

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

| Course | Marks | CAT & Mid Term Theory | | | | CAT Practical | | Best Scored CAT & Mid Term | SEE | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | | | 4 | | 5 | 6 | 5 + 6 |
| | | Att. | CAT I | Mid Term | CAT II | Att. | CAT | | | |
| **Research Methodology** | 100 | 10 | 10 | 20 | 10 | - | - | 40 | 60 | 100 |
| **MMC/MEC** | 100 | 10 | 10 | 20 | 10 | - | - | 40 | 60 | 100 |
| **Field Project** | 100 | 10 | 10 | 20 | 10 | - | - | 40 | 60 | 100 |

**Notes:**

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)