Rajarshi Shahu Mahavidyalaya (Autonomous),Latur

Department of Mathematics

Year 2020-21

Syllabus for

M.Sc.-II (Mathematics)

CBCS Pattern

w.e.f. 2018-2019

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
BoS in Mathematics

1. **Introduction:**

M. A. / M. Sc. Mathematics program is of minimum 100 credits spread over four semesters. The program emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, a large number of elective courses, extensive computer training including standard software packages such as LATEX MATLAB,. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. The syllabus of the first year (two semesters) covers four core courses and one elective from three choices .The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics. It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives.

The courses for the PG Program 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.

In this program there are core courses and optional papers .The M.Sc program is so designed that those who is having B.Sc (General)/B.Sc (Honors) streams can study M.Sc Papers without any difficulties. The optional Papers are purely foundational courses for further research where as Core courses are purely NET/SET/GATE oriented.

The inclusion of Computer based courses has several advantages. The students offering these courses will be in demand in industry and shall get preference in teaching and research institute.

As learning Mathematics is doing Mathematics, to this end, some activities are prescribed to increase student's participation in learning. Duration of the degree program shall be four semesters distributed in a period of two academic years.

2. Title of the Course: M.Sc. (Mathematics)

3. Objectives of the Course:

Successful Mathematics students of this institute will gain lifelong skills, including following:

- To develop their mathematical knowledge and oral, written and practical skills in a way which encourages confidence and provides satisfaction and enjoyment.
- The development of their mathematical knowledge.
- Confidence by developing a feel for numbers, patterns and relationships.
- An ability to consider and solve problems and present and interpret results.
- Communication and reason using mathematical concepts.
- To develop an understanding of mathematical principles.
- To develop the abilities to reason logically, to classify, to generalize and to prove.
- To acquire a foundation appropriate to their further study of research fields in mathematics and of other disciplines.

4. Advantages of the Course:

Student will be getting highly motivated for higher studies in research fields of mathematics

5. Duration of the Course:	Two years
6. Eligibility of the Course:	**For M.Sc. I :**B.Sc. with Mathematics as principal Subject at degree level.
7. Strength of the Students:	30
8. Fees for Course:	As per UGC/University/College rules.
9. Period of the Course:	As per UGC/University/College rules
10. Admission / Selection procedure:	As per UGC/University/College rules
11. Teacher's qualifications:	As per UGC/University/College rules
12. Standard of Passing:	As per UGC/University/College rules
13. Nature of question paper with scheme of marking:	As per UGC/University/College rules
15**. List of book recommended**:	Included in syllabus
16. **List of Laboratory Equipments, Instruments, Measurements etc.:**	Matlab Software with one computer Lab
17. **Rules and regulations and ordinance if any:**	As per UGC/University/College rules

18. Medium of the language:	English
19. Structure of the Course:	Attached as Annexure ‘A’
20. Allotment of workload (Theory/Practical):	Attached as Annexure ‘A’
21. Staffing pattern:	As per UGC/University/College rules.
22. Intake capacity of students:	As per UGC/University/College rules
23. Paper duration:	Each theory paper is of 45Contact hours
24. To be introduced from:	**M. Sc. II from June 2018**

Chairman Board of Studies
Mathematics

(Mr. M. S. Wavare)

Program Outcomes

Successful PG Mathematics students of this institute will gain lifelong skills, including following:

1. They can qualify CSIR-NET/SET/GATE
2. They will get tune with further studies of their area of interest
3. They can be good teacher in Mathematics
4. They can get placed in job of Scientific Computing /Data Analyst
5. They can become good citizen

List of BoS Members

1. **Dr. D D Pawar (VC Nominee)**

   Director,School of Mathematical Sciences

   Swami Ramanand Teerth Marathwada University,

   Nanded.

2. **Prof. N. S. Darkunde (Subject Expert)**

   School of Mathematical Sciences

   Swami Ramanand Teerth Marathwada University, Nanded.

3. **Dr. S S Bellale (Subject Expert)**

   Head , Department of Mathematics,

   Dayanand Science College Latur

4. **Prof.L K Gitte**

   Armament Research Development Estb

   Pashan Pune

5. **Dr. A. A. Muley (Co-option)**

   School of Mathematical Sciences

   Swami Ramanand Teerth Marathwada University, Nanded.

6. **Prof .S M Shinde (Student Allumni)**

   Government College of Engg. Karad

7. **Prof. N . S. Pimple,**

   R S M , Latur

8. **Prof. S. P. Birajdar ,**

   R S M , Latur

9. **Dr. A. A. Yadav ,R S M , Latur**

Annex ure 'A'

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

Department of Mathematics

M.Sc. II (CBCS) Semester III

Curriculum Structure with effect from June, 2018

Course Code	Paper Number	Title of the course with paper number	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
P-FUA-365	XI	Ring Theory	06	40	60	04
P-LIE-366	XII	Functional Analysis	06	40	60	04
Elective-III P-COT-367(A) P-FRC-367(B)	XIII(A) III(B)	Coding Theory –I Or Fractional Calculus-I	06	40	60	04
Elective-IV P-CLM-368(A) P-NLA-368(B)	XIV	Classical Mechanics Or Numerical Linear Algebra-I	06	40	60	04
P-LAB-369	LAB-III	Foundations of Analysis-I	06	40	60	04
P-LAB-370	Project	Project	04	40	60	04
P-SEM-371	P-SEM-	Seminar	01	--	25	01
		Total Credits				25

Student Stay Hours: 35/Week

Annex ure 'A'

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

Department of Mathematics

M.Sc. II (CBCS) Semester IV

Curriculum Structure with effect from June, 2018

Course Code	Paper Number	Title of the course with paper number	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
P-FIT-461	XV	Field Theory	06	40	60	04
P-LIE-462	XVI	Linear Integral Equations	06	40	60	04
Elective-V P-COT-463(A) P-FRC-463(B)	XVII(A) XVII(B)	Coding Theory –II Or Boundary Value Problems	06	40	60	04
Elective-VI P-CLM-464(A) P-NLA-464(B)	XVIII(A) XVIII(B)	Numerical Analysis Or Numerical Linear Algebra-II	06	40	60	04
P-LAB-465	LAB-IV	Foundations of Analysis-II	06	40	60	04
P-LAB-466	Project	Project	04	40	60	04
P-SEM-467		Seminar	01	--	25	01
		Total Credits				25

Student Stay Hours: 35/Week

M. Sc. – II [Mathematics] Semester III

Course Code: P-RIT-364

Ring Theory

Paper-XI

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Basic properties of rings, examples of rings,
- ideals, algebra of ideals
- Homomorphism and isomorphism of rings
- Integral domain, U.F.D'S, P.I.D's and E.D'S

Course Outcomes: after successful completion of this course students will be Familiarized with the

- Different useful types of rings
- Concept of ideals and quotienting
- Similarities between two rings by means of homomorphism and isomorphisms
- Integral domain, U.F.D's, P.I.D's and E.D's

Unit-I: Rings

Terminology, Rings of Continuous Functions, Matrix Rings , Polynomial Rings, Power Series Rings , Laurent Rings , Boolean Rings ,Some Special Rings ,Direct Products ,Several Variables ,Opposite Rings , Characteristic of a Ring .

Unit-II: Ideals

Definitions, Maximal Ideals, Generators, Basic Properties of Ideals , Algebra of Ideals ,Quotient Rings ,Ideals in Quotient Rings , Local Rings.

Unit-III: Homeomorphisms of Rings

Definitions and Basic Properties, Fundamental Theorems Endomorphism Rings Field of fractions Prime fields

Unit-IV: Factorization in Domains

Division in Domains, Euclidean Domains, Principal Ideal Domains, Factorization Domains, Unique Factorization Domains, Eisenstein's Criterion ,

Reference Books

1. **C. Musili,** Introduction to RINGS AND MODULES Second Revised Edition, Narosa Publishing House

2. **P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul**, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

3. **Joseph A. Gallian**, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.

4. **V.K. Khanna, S.K. Bhambri**, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)

5. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

M. Sc. – II [Mathematics] Semester III

Course Code: P-FUA-365

Paper-XII

Functional Analysis

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- The Hahn-Banach Theorem
- Properties of Hilbert spaces
- Operators
- The spectral theory

Course Outcomes:

After successful completion of the course students will able to

- Work on continuous linear transformation
- Apply and prove open mapping theorem
- Apply and prove the spectral theory

Unit-I:

Definition and some Examples of Banach Spaces, continuous linear transformations, The Hahn-Banach Theorem, The Natural embedding of N in N**. **(15L)**

Unit-II:

The open Mapping Theorem, The conjugate of an operator. The definition and some simple properties of Hilbert Spaces, orthogonal complements, orthonormal sets. **(15L)**

Unit-III:

The conjugate space H*, The adjoint of an operator, self adjoint operators, Normal and Unitary Operators, projections. **(15L)**

Unit-IV:

Finite Dimensional Spectral Theory: Introduction, Matrices, Determinants and spectrum of an operator, The spectral Theorem. **(15L)**

Reference Books:

1.**G.F. Simmons**, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, International student Edition, New York.
2.. **B.V. Limaye**, Functional Analysis, Wiley Eastern Ltd.
3. **G. Bachman and L. Narici,** Functional Analysis.
4. **Kreyszig ,** Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978Academic Press 1966.
5. **J. B. Conway**, A course in functional analysis, Springer-Verlag, New York 1990.
6. **S.Ponnusamy**, Foundations Of Functional Analysis, Narosa Publishing House

M. Sc. – II [Mathematics] Semester III

Course Code: P-COT-366(A)(Elective-III)

Paper-XIII(A)

Coding Theory –I(A)

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- *Hamming distance*
- *Finite fields*
- *Linear codes*
- *Some Codes and their bounds*

Course Outcomes:

After successful completion of the course the students are able to

- Decoding the distance of code
- Use the theory of finite fields in coding and decoding
- Find parity check matrix and equivalence of linear codes
- Use the bounds of different linear codes

Unit I

Error detection, correction and decoding introduction, Communication channels, Maximum livelihood decoding, Hamming distance, nearest neighbor / minimum distance, decoding distance of a code. [12 lectures]

Unit II

Fields polynomials rings structure of finite fields, minimal polynomials vector spaces over finite fields. [12 lectures]

Unit III

Linear codes , Hamming weight bases for linear codes , Generator matrix and parity check matrix, Equivalence of linear codes , Encoding with linear codes , Decoding of linear codes, Cosets nearest neighbor ,decoding for linear codes syndrome decoding . [16 lectures]

Unit IV

The main coding theory problem lower bounds sphere covering bound Gilber-Varshamav bound hamming bounds and perfect codes, Binary haming codes q-ray hamming codes, Goley code some remarks on perfect codes singleton bounds and MDS codes, Plotain bound, non linear codes , Hadmand matrix code, Nordstrom-Robinson code , preparata codes .[20 lectures]

Reference Books

1. San Ling , Chaoping Xing "Coding Theory A First course" Cambridge University Press.

2. F J MacWilliams and N J A Sloane, "The Theory of Error –Correcting Codes" North-Holland Volume 16.

3. Lid and Pilz , "Applied Abstract Algebra" - 2nd Edition.

4**. R. Lidl, H.Neiderreiter** , "Introduction to finite fields and their applications", Cambridge University Press.

M. Sc. – II [Mathematics] Semester III

Course Code: P-FRC-366(A)(Elective-III)

Paper-XIII(B)

Fractional Calculus

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- Mittag-Leffler Functions of one and two parameters
- fractional derivatives
- Fractional integrals
- To solve fractional differential equations

Course Outcomes:

After successful completion of this course students are able to

- Calculate fractional derivatives and fractional integrals
- Do geometric and physical interpretation of fractional integral and fractional differentiations
- Solve fractional differential equation

Unit I:

Gamma and Beta Functions: Definition of the Gamma and Beta Functions, Some properties of Gamma and Beta Functions, Relation between Gamma and Beta Functions. Special Function: Definition of Mittag-Leffler Functions of one and two parameters, Relations of Mittag-Leffler Function to some other functions, The Laplace transform of Mittag-Leffler Function in two parameters. Wright Function, Definition of Wright function,. **(15L)**

Unit II:

Integral relation and relation to other functions Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivatives, Caputo's fractional derivative, Fractional derivatives of standard functions and their graphical representation by Mathematical softwares, Fractional integrals, **(15L)**

Unit III:

Geometric and physical interpretation of fractional integral and fractional differentiations. Left and right fractional derivatives. Laplace transform of fractional derivatives, Fourier transform of fractional derivatives and Mellin transform of fractional derivatives. **(15L)**

Unit IV:

Applications: Linear fractional differential equations (homogeneous fractional differential equations and non-homogeneous fractional differential equations), Existence and uniqueness theorem as a method of solution, Laplace transform method to solve fractional differential equations, **(15L)**

Reference books:

1.Igor Podlubny - Fractional Differential Equations, Academic press, San Diego, California.
2.. Miller K. S. and Ross B. – An Introduction to Fractional Calculus and Fractional Differential Equations, New York, John Wiley, 1993.
3.. Oldham K. B. and Spanier J. – The Fractional Calculus, New York, Academic press, 1974.
4. Igor Podlubny - Fractional Differetial Equations, Academic Press, Boston, New York.
5. Anatoly A. Kilbas, Hari M. Shrivastav, Juan J. Trujillo- Theory and Applications of Fractional Differential Equations, Elesevier, New York 2006.
6. Shananu Das – Functional Fractional Calculus, 2011 Springer-Verlag, Berlin Heidelberg.

M. Sc. – II [Mathematics] Semester III

Course Code: P-COT-367(A)(Elective-IV)

Paper-XIV(A)

Classical Mechanics (A)

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- D' Alembert's Principle, Lagrange's equations of motion
- Euler- Lagrange's equations
- Hamiltonian and least action principle
- Kinematics of rigid body motion.

Course Outcomes:

After successful completion of this course students will be

- Well understood the mechanics of the system of particles
- Able to apply Euler Lagrange's equation to extremis the functional.
- Well understood The Kinematics of rigid body motion

UNIT – I

Mechanical of system of particles, Mechanics of system of particles, Conservation theorems conservative forces with examples, Constraints, Generalized co-ordinates. D. Alembert's principle, Lagrange's equations of motion. The forms of Lagrange's equations of motion for non conservative systems and partially conservative and partially non conservative systems. Kinetic energy as a homogeneous function of generalized velocities. Simple applications of the Lagranian formulation. (**15 Lectures**)

UNIT – II

Cyclic co-ordinates and generalized momentum conservation Theorems, Calculus of variation, Euler Lagrange's equation, First integrals of Euler Lagrange's equation, the case of several dependent variables, Geodesics in a plane, the minimum surface of revolution, Brachistochrome problem. Isoperimetric problems, problems of maximum enclosed area. (**15 Lectures**)

UNIT – III

Hamiltonian function, Hamilton's canonical equations of motion, Derivation of Hamilton's equations from variational principle, Physical significance of Hamiltonian, the principle of least action, Jacobi's form of the least action principle, cyclic co-ordinates and Routh's procedure.

(**15 Lectures**)

UNIT – IV

The independent co-ordinates of a rigid body, Orthogonal transformations,Properties of transformation matrix, Infinitesimal rotations, The Eulerian angles, The Calyley-Klein parameters, Eulers theorem on motion of rigid body, Angular momentum and kinetic energy of motion of a rigid body about a point. **(15 Lectures)**

Reference books:-

1) Goldstein, H. Classical Mechanics. (1980), Narosa PublishingHouse, New Delhi.

2) Weinstock: Calculus of Variations with Applications to Physics and Engineering (International Series in Pure and Applied Mathematics). (1952), Mc Graw Hill Book Company, New York.

3) Whittaker, E. T. A treatise on the Analytical Dynamics of particles and rigid bodies. (1965), Cambridge University Press.

4) Rana, N.C. and Joag, P. S. Classical Mechanics. (1991) Tata McGraw Hill, New Delhi.

5) Bhatia, V. B. Classical Mechanics with Introduction to Non-linear Oscillation and Chaos.(1997), Narosa publishing House.

6) Gupta, A. S. Calculus of Variations with Applications (1997), Prentice Hall of India.

7) Gelfand, I. M. and Fomin, S. V. Calculus of Variations (1963), Prentice Hall of India. 4) Mondal, C. R. Classical Mechanics (2001), Prentice Hall of India.

M. Sc. – II [Mathematics] Semester III

Course Code: P-NLA-367(B)(Elective-IV)

Paper-XIV(B)

Numerical Linear Algebra –I

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- *Review of linear algebra*
- *Computer Arithmetic's*
- *Conditional number*
- *Stability of non-linear system*

Course Outcomes:

After successful completion of this course students will able to

- Diagonalize matrix
- Do sign integer representation of numbers
- Discuss the stability of systems

Unit 1:

Matrix operations and type of matrices, Determinant of a Matrix, Rank of a matrix, Vector Spaces, Linear dependence and independence, Bases and Dimensions, Linear Transformation Orthogonal subspaces, Row space, column space and null Space, Eigenvalues and Eigenvectors, Diagonalizable Matrices

Unit 2:

Orthogonal Sets, Gram Schmidt orthogonalization and orthonormal bases, Introduction to Matlab, Sign integer representation Computer representation of numbers.

Unit 3: Floating point representation, Round-off error, Error propagation in computer arithmetic, Addition and multiplication of floating point numbers,

Unit 4: Conditioning and condition numbers, Stability of numerical algorithms, Vector norms, Matrix Norms, Convergent Matrices, Stability of non-linear system

Reference Books :

1.V. Sundarapandian, Numerical Linear Algebra, PHI, 2008.
2. Biswa Nath Dutta, Numerical Linear Algebra and Applications, SIAM, 2010.

3. Roger A. Horn and Charles R. Johnson, Matrix Analysis, Cambridge University Press,1994
4. William Ford, Numerical Linear Algebra with Applications, Academic Press, 2014.

M. Sc. – II [Mathematics] Semester III

Course Code P-LAB-368

Lab Course –III

Lab work (Foundation of Analysis-I)

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- **Set theory and countability of set.**
- **Convergences of sequences and series.**
- **Archimedean property ,Bolzano Weierstrass property.**
- **Uniform Convergence.**

Course Outcomes

After completing this course students are able to solve problems on

- **Basic Real analysis**
- **Sequence and series of functions**
- **Uniform Convergence**

Section -I

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf.

Section-II

Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence

Note : Students will have to solve examples on this course from SET/NET/GATE/NBHM

entrance questions

Reference Books :

1. N.L. Carothers, Real Analysis, Cambridge University Press.
2. W. Rudin, Principles of Mathematical Analysis.
3. C. C. Pugh, Real Mathematical Analysis.
4. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House.
5. T. M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis, Springer Publications.
7. Ajit Kumar and S. Kumaresan, Basics of Real Analysis, CRC Press.

M. Sc. – II [Mathematics] Semester III

Course Code P-PRO-369

Project-I

Project Work

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Identify and define a significant issue relevant to the discipline of the degree.
- Systematically collect relevant up-to-date information about the issue, either directly or from published studies or publicly available data
- Draw conclusions and make recommendations relevant to the issue that will contribute to current knowledge
- Write and present a report in accordance with academic standards at a postgraduate level

Course Outcomes:

Completing a project as part of M.Sc is an opportunity to:

- learn to read and interpret other people's research critically by doing your own. This gives you an insight into the effects of practical difficulties and theoretical debates on published research
- Submit a paper for peer-reviewed publication. (If successful, this will give a boost to your c.v.)
- One can continue his work for further research in M.Phill or Ph.D

During this semester students will be allotted Guide for doing their projects and as per students interest the topic is finalized. Guide will ask to do literature survey on the related topic .The corresponding students has to write synopsis of his work and literature survey made during this semester. 40 marks for internal and 60 for semester evaluation

40 marks =20 marks for attendance as per attendance rule +20 for write up

60marks = 20 Marks for synopsis +20 Marks on literature survey +10 marks for ppt presentation of the work +10 marks for Viva/Oral.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-FIT-464

Paper-XV

Title-Field Theory

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Algorithm for factorization
- Fields Extension
- Normal and Separable extension
- Galois Group

Course Outcomes:

After successful completion of this course students will be able to

- Apply Schoneman-Eisenstein criterion
- Find degree of extension using tower theorem
- Apply theory of splitting fields
- Find Galois group.

Unit-I: Introduction

Definition and examples of fields, Minimal polynomial, adjoining elements, irreducible polynomial, Algorithm for factorization, The Schoneman- Eisenstein criterion,

Unit-II: Fields Extension

Prime radicals, historical notes, the degree of extension, Finite Extensions, The Tower theorem, Algebraic extension, mathematical notes.

Unit-III Normal and Separable extension

Splitting fields Definition and examples, Uniqueness of splitting fields, Normal extensions, Separable extension, Fields of characteristic zero, Fields of characteristic p, Computations, Mathematical notes ,historical notes , Theorem of primitive element.

Unit-IV: The Galois Group

Definition of the Galois Group, Historical notes, Galois group of splitting fields, Permutations of the roots Mathematical notes, examples of Galois groups, The p^{th} roots of 2, The Universal Extension ,a polynomial of degree 5,Mathematical notes ,Historical notes

Reference Books

1. **David A Cox,** "Galois Theory**"**. Second edition,A John Wiley and Sons ,INC ,publication

2.**P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul**, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

3. **V.K. Khanna, S.K. Bhambri**, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)

4. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-LIE-465

Paper-XVI

Title : Linear Integral Equations

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- Convolution
- Volterra integral equations of first and second kind
- Laplace Transform applications to solve Volterra integral equations

Course Outcomes:

After successful completion of the course Students will able to

- Solve integral equations
- Classify the integral equations

Unit-I:

Definition and classification of integral equations, Special kinds of kernels,Convolution integrals, Conversion of an initial value problem into a Volterra integral equation, Conversion of a boundary value problem into a Fredholmintegral equation, Eigen values and eigen functions, Solution of homogeneous Fredholm integral equations of the second kind with separable kernel, Fredholm alternative.

Unit-II:

Method of successive approximation, Iterated kernel, Resolvent kernel, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive substitutions, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive approximations:Neumann series.

Unit-III:

Integral equations with symmetric kernels, Regularity conditions, Complex Hilbert space, An orthonormal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen functions and bilinear form, Hilbert-Schmidt theorem and some immediate consequences. Singular integral equations, The Abel integral equation examples,

Unit-IV

Integral transform method, Application of Laplace transform to solve Volterra integral equations with convolution type kernels, Application of Fourier transform to solve integral equations, Examples.

Reference Books

1. R.P. Kanwal, *Linear Integral Equantions Theory and Technique*, Academic Press, Inc., New York.

2. Dr. M. D. Raisinghania, *Integral Equations and Boundary Value Problems*, S. Chand and Company Pvt. Ltd., New Delhi.

3. S.G. Mikhlin, *Linear integral equations* (Translated from Russian) "Hindustan Book Agency 1960.

4. B.L. Moiseiwitsch, *Integral Equations*, Longman, London & New York.

5. M. Krasnov, A Kiselev, G.Makaregko, *Problems and Exercises in integral equations* (Translated from Russian) by George Yankovsky) MIR Publishers Moscow, 1971.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-COT-II-466(A)(Elective-V)

Paper-XVII(A)

Coding Theory –II(A)

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- Reed –Mullar codes
- Decoding of cyclic codes
- Some special cyclic codes
- Goppa codes

Course Outcomes:

After Successful completion of this course students will able to

- Construct a linear code
- Discuss some special cyclic codes

Unit I Linear Codes

Construction of Linear codes, propogation Reed -Mullar codes, Subfield codes[10 lectures]

Unit II Cyclic Codes

Definition of cyclic codes, generator polynomial, Generator and parity check matrices, Decoding of cyclic codes, Bust error correcting codes.[16 lectures]

Unit III Some special cyclic codes.

B.C.H codes, definations, Parameters of B.C.H codes, Decoding of B.C.H codes, Reed Soleman codes, Quadratic rercidue code.[18 lectures]

Unit IV Goppa Codes

Generelised reed – Solemon codes , Alterment codes , Goppa codes, Sudaan decoding or Generalized R.S codes, Generation of (p,k,t) polynomial.[16 lectures]

Reference Books

1. San Ling , Chaoping Xing "Coding Theory A First course" Cambridge University Press.

2. F J MacWilliams and N J A Sloane, "The Theory of Error –Correcting Codes" North-Holland Volume 16.

3. Lid and Pilz , "Applied Abstract Algebra" - 2nd Edition.

4**. R. Lidl, H.Neiderreiter** , "Introduction to finite fields and their applications", Cambridge University Press.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-FRC-II-467(B)(Elective-III)

Paper- XVII(B)

Boundary Value Problems

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- Boundary Value Problems
- Sturm-Liouville problems
- Legendre polynomials

Course Outcomes:

After successful completion of the course students are able to

- Apply Principal of Superposition
- Find applications of sturm-Liouville Problem
- To solve Legendre polynomials

Unit I

Definition of boundary Value Problems, the heat equation, wave equation, Laplace's equation, the Fourier method, Liner Operators, Principal of Superposition, series solutions, uniform convergence (weierstrass M-test), separation of variables, non homogeneous conditions.

Unit II

Sturm-Liouville problems, formal solutions, the vibrating string, Orthogonal sets of functions, Generalized Fourier series, Best approximation in the mean, Convergence in the mean, the orthonormal trigonometric functions, other types of orthogonality.

Unit III

Sturm-Liouville Problem and applications, orthogonality and uniqueness of eigen functions, method of solutions, surface heat transfer other boundary value problems.

Unit IV

Legendre polynomials, orthogonality of Legendre polynomials, Legendre series, Dirichlet Problem in spherical regions.

Reference Books

1. **R.V. Churchill and J. Brown "** Fourier Series and Boundary Value Problems" (4_{th} edition)(Publisher: McGraw-Hill Book Company)
2. **Ram P.Kanwal, Birkhauser** "Linear Integral Equations"(Theory and Technique)
3. **M. D. Raisinghania** "Advanced Differential Equations"(12th Revised Ed) –,S. Chand pub.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-NUA-468(A)(Elective-VI)

Paper-XVIII(A)

Title :Numerical Analysis (A)

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

The course will develop numerical methods aided by technology to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integrals. The course will also develop an understanding of the elements of error analysis for numerical methods and certain proofs. The course will further develop problem solving skills.

Course Outcomes:

- Solve an algebraic or transcendental equation using an appropriate numerical method
- approximate a function using an appropriate numerical method
- solve a differential equation using an appropriate numerical method
- evaluate a derivative at a value using an appropriate numerical method

Unit I

Iterative solutions of nonlinear equation: bisection method. Fixed-point interation, Newton's method, secant method, accelera- tion of convergence, Newton's method for two non linear equations, polynomial equation methods.

Unit II

Polynomial interpolation: interpolation polynomial, divided dif- ference interpolation, Aitken's formula, finite difference formulas, Hermite's interpolation, double interpolation.

Unit III

Linear systems of Equations: Gauss Elimination, Gauss-Jordan method, LU decomposition, iterative methods, and Gauss- Seidel iteration.

Unit IV

Numerical Calculus : Numerical differentiation, Errors in numer- ical differentiation, Numerical Integration, Trapezoidal rule, Simp- son's 1/3 - rule, Simpson's 3/8 rule, error estimates for Trapezoidal rule and Simpson's rule.

Reference Books

S. S. Sastry, Introduction Methods of Numerical Analysis (4th Edition)(Prentice-Hall).

2. K .E. Atkinson,: An Introduction to Numerical Analysis.

3. J. I. Buchaman and P. R. Turner, Numerical Methods and Analysis.

M. Sc. – II [Mathematics] Semester IV

Course Code: P-NLA-468(B)(Elective-VI)

Paper-XVIII (B)

Numerical Linear Algebra –II

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- Condition number of a matrix
- SVD and their applications
- QR factorization
- Power method

Course Outcomes:

After successful completion of this course students are able to

- Calculation of condition numbers of matrix
- Finding rank of matrix using SVD
- Find QR factorization
- Apply power method and Jacobi method.

Unit 1:

Condition number of a matrix: Elementary properties, Sensitivity analysis, Residual theorem, Nearness to singularity, Estimation of the condition number, Singular value decomposition of a matrix, Orthogonal Projections, Algebraic and geometric properties of matrices using SVD.

Unit 2: SVD and their applications, Perturbation theorem for singular values, Outer product expansion of a matrix, Least square solutions.

Unit 3: Psudeo - inverse and least square solution, Householder matrices and their applications, Householder QR factorization, Basic theorems on eigenvalues and QR method

Unit 4: Power method, Rate of convergence of Power method, Applications of Power method with shift, Jacobi method.

Reference Books

1.V. Sundarapandian, Numerical Linear Algebra, PHI, 2008.

2. Biswa Nath Dutta, Numerical Linear Algebra and Applications, SIAM, 2010.

3. Roger A. Horn and Charles R. Johnson, Matrix Analysis, Cambridge University Press, 1994.

4. William Ford, Numerical Linear Algebra with Applications, Academic Press, 2014.

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M. Sc. – II [Mathematics] Semester III

Course Code P-LAB-369

Lab Course –I

Lab work (Foundation of Analysis-II)

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- Riemann Integral
- Improper Integral
- Functions of several variables

Course Outcomes

After completion of this course students are able to

- Solve examples on Riemann integrable functions
- Solve examples on basics of calculus and analysis

Section-I

Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation.

Section-II

Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness.

Note : Students will have to solve examples on this course from SET/NET/GATE/NBHM

entrance questions

Reference Books :

1. N.L. Carothers, Real Analysis, Cambridge University Press.
2. W. Rudin, Principles of Mathematical Analysis.
3. C. C. Pugh, Real Mathematical Analysis.
4. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House.
5. T. M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis, Springer Publications.
7. Ajit Kumar and S. Kumaresan, Basics of Real Analysis, CRC Press.

M. Sc. – II [Mathematics] Semester III

Course Code P-PRO-470

Project-II

Project Work

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Identify and define a significant issue relevant to the discipline of the degree.
- Systematically collect relevant up-to-date information about the issue, either directly or from published studies or publicly available data
- Draw conclusions and make recommendations relevant to the issue that will contribute to current knowledge
- Write and present a report in accordance with academic standards at a postgraduate level

Course Outcomes:

Completing a project as part of M.Sc is an opportunity to:

- learn to read and interpret other people's research critically by doing your own. This gives you an insight into the effects of practical difficulties and theoretical debates on published research
- Submit a paper for peer-reviewed publication. (If successful, this will give a boost to your c.v.)
- One can continue his work for further research in M.Phill or Ph.D

During this semester students will be allotted Guide for doing their projects and as per students interest the topic is finalized. Guide will ask to do literature survey on the related topic .The corresponding students has to write synopsis of his work and literature survey made during this semester. 40 marks for internal and 60 for semester evaluation

40 marks =20 marks for attendance as per attendance rule +20 for write up

60marks = 20 Marks for Project +20 Marks if research work communicated to reputed Journal /Conference proceedings +10 marks for ppt presentation of the work +10 marks for Viva/Oral.

Practical Examination Paper Pattern for M.Sc-II

RSML

Practcal Paper

Maximum Marks 60 **Time: 3 hours**

NB i) All questions are compulsory

ii) Figures to the right indicates Full Marks

Q1 Oral /Viva	**10**
Q2 Solve any one	**05**
a)Section –I	
b)Section-I	
Q3 Solve any one	**05**
a)Section –II	
b)Section-II	
Q4 Solve any two	**20**
a)Section –I	
b)Section-I	
c)Section -I	
Q5 Solve any two	**20**
a)Section –II	
b)Section-II	
c)Section -II	