SECOND SEMESTER SYLLABUS

M. Sc. MATHEMATICS

BABA GHULAM SHAH BADSHAH UNIVERSITY RAJOURI, J&K, INDIA

COURSE SCHEME

COURSE CODE	COURSE TITLE	NO. OF CREDITS	DISTRIBUTION OF MARKS		
			SA	UE	TOTAL
MS - 231	Numerical Linear Algebra	4	40	60	100
MS - 232	Functional Analysis with Applications	4	40	60	100
MS - 233	Abstract Algebra with Applications	4	40	60	100
MS - 234	Complex Analysis with Applications	4	40	60	100
MS - 235	Elements of Accountancy	2	20	30	50
Choice based open elective course (Students are required to opt one course from a list of courses offered by different departments of the university at the beginning of semester second.)		4	40	60	100
MS - 236	MatLab	2	25	25	50
	TOTAL	24	245	355	600

SA: Sessional Assessment
UE: University Examination

SEMESTER - II

Course Title	Numerical Linear Algebra	Maximum Marks	100
Course Code	MS-231	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …...................		The main objective of this course is to introduce students to the fundamentals of linear algebra and numerical solutions of problems of linear algebra.
UNIT 01	Matrices	Review of fundamental concepts of vector space; Matrix of a linear transformation; matrix of sum and composition of linear transformations; change of basis matrix; similar matrices; determinant of a matrix and its basic properties; permutation and its signature; uniqueness of determinant map.
UNIT 02	Spectral Theorey	Eigen values and eigen vectors of a matrix and a linear transformation; algebraic and geometrical multiplicities of an eigen value; diagonalizable linear mapping/matrix; Cayley-Hamilton theorem; minimum polynomial of a matrix and its properties; invariant subspaces of a vector space; primary decomposition theorem (statement only) and its special cases; necessary and sufficient conditions for simultaneous diagonalization of two matrices.
UNIT 03	Canonical and Bilinear Forms	Nilpotent linear transformations; existence of triangular matrix; Jordan decomposition theorem (statement only); index of a nilpotent linear transformation and its elementary properties; Jordan Block matrix; Jordan form; Jordan basis; bilinear form; symmetric and skew symmetric bilinear forms; quadratic form and its properties; Sylvester's theorem; positive definite quadratic form
UNIT 04	Numerical methods for linear systems	Gauss elimination method; Gauss Jordan elimination method; pivoting; LU factorization method; Doolittle method; Crout's method; Cholisky's method; Jacobi iteration method; Gauss Seidel iteration method; matrix norms; introduction to ill conditioning; well conditioning and condition number of a matrix.
UNIT 05	Numerical methods for finding eigen values and eigenvectors	Power method; shifted inverse power method; Jacobi's method; Householder's method; Householder's reflection theorem; Householder's transformation and its computation; QR method; Gerschgorian's theorem; Peron's theorem; Schur's theorem.

COURSE OUCOMES

On successful completion of this course, we expect that a student

1 explain vector space, linear dependence / independence, basis and dimension, linear transformation, change of basis matrix, permutation and its signature.

2 explain the concept of characteristic polynomial to compute the eigen values and eigen vectors of a square matrix and Cayley-Hamilton theorem.

3 explain the concept of minimum polynomial of a matrix and its properties, primary decomposition theorem and diogonalization.

4 explain the concept of Nilpotent linear transformations, Jordan decomposition theorem, Jordan Block Matrix, Jordan form, Jordan basis.

5 explain the concept of bilinear forms, symmetric and skew symmetric bilinear forms, quadratic form and its properties.

6 explain the numerical methods such as Gauss- Jordan elimination method, LU factorization method, Doolettle method, Crout's method, Cholisky's method, Gauss-Seided iteration method for solving the system of linear equations.

7 explain the numerical methods such as power method, Jocabi's method, Household's method, QR method and theorems such as Gerschgorian's theorem, person's theorem.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Blyth, T.S. and Robertson, E. F., (2007),** Basic Linear Algebra, 2nd Edition, Spinger.

2. **Blyth, T.S. and Robertson, E. F., (2008)**, Further Linear Algebra, 2nd Edition, Spinger.

3. **John, H. M. and Kurtis, D. F., (2007)**, Numerical Methods using Matlab, 4th edition, Prentice Hall of India Pvt. Limited, New Delhi.

REFERENCE BOOKS

1. **Golub, G. and Loan, C. Van, (1996)**, Matrix Computations, 3rd edition, John Hopkins University Press.

2. **Jain, M.K., Iyenger, S.R.K. and Jain, R.K., (2007),** Numerical Methods for Scientific and Engineering Computation, 5th edition, New Age International Publication, New Delhi.

3. **Kreyszig, E.,** Advanced Engineering Mathematics, 8th Edition, Wiley India Private limited.

SEMESTER - II

Course Title	Functional Analysis with Applications	Maximum Marks	100
Course Code	MS-232	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …....................		The main objective of this course is to introduce students to the fundamentals of functional analysis and make them aware of its applications.
UNIT 01	Normed Spaces	Definition, examples and basic properties of normed spaces; completeness and equivalence of norms on finite dimensional normed spaces; characterization of compact sets in finite dimensional normed spaces; Riesz lemma; introduction to L^p -spaces.
UNIT 02	Linear operators on normed spaces	Definition and basic properties of bounded linear operators; connection between continuity and boundedness of linear operators; continuity of linear operators on finite dimensional spaces; completeness of normed space of operators; dual spaces of R^n and l^p spaces, Hahn Banach extension theorem for normed spaces and its consequences.
UNIT 03	Inner Product spaces	Definition and basic properties of IPS; Hilbert spaces; existence of minimizing vector; orthogonality; Projection theorem; orthogonal complement of a set and its basic properties; Bessel's inequality; total orthonormal sets; Parseval's relation; connection between separability and orthonormal sets; isomorphism of Hilbert spaces of same dimension.
UNIT 04	Inner product spaces and Banach fixed point Theorem	Riesz theorem; sesquilinear forms; Riesz representation for sesquilinear forms; Hilbert adjoint operator and its basic properties; basic properties of self adjoint, unitary and normal operators; Banach fixed point theorem and its applications to differential and integral equations -Picard's existence and uniqueness theorem, Fredholm and Volterra integral equations.
UNIT 05	Reflexive spaces and fundamental theorems	Reflexive spaces; Hilbert spaces and finite dimensional normed spaces as examples of reflexive spaces; separability of dual normed space as a sufficient condition for the separability of the normed space; uniform boundedness theorem and its application to space of polynomials and Fourier Series; Open mapping and closed graph theorems.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1. should be able to explain the concept of inner product and norm on a vector space.
2. should be able to explain the concept of normed, Banach & Hilbert spaces with standard examples and relation between them.
3. should be able to explain the concepts of bounded linear operator & bounded linear functional with standard examples.
4. should be able to explain the properties of linear operators on finite and infinite dimensional normed spaces.
5. should be able to explain the dual spaces of R^n and l^p spaces and completeness of the normed space of operators.
6. should know the Banach contraction principle with applications to differential & integral equations.
7. should know the fundamental theorems such as Riez Lemma, Hahn Banach extension theorem, closed graph theorem, open mapping theorem, Principle of uniform boundedness, Bessel's inequality, projection theorem, Pansevals relation, Baire Category theorem and Riesz theorem with applications.
8. should be able to explain the concept of separable and reflexive normed spaces.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Kreyszig, E., (2006),** Introductory Functional Analysis with Applications, 1st edition, **Wiley Student edition.**

REFERENCE BOOKS

1. **Bachman, G. and Narici, L., (1966),** Functional Analysis, **Academic Press New York.**
2. **Cheney, W., (2000),** Analysis for Applied Mathematics, **Springer.**
3. **Rynne, B. P. and Youngson, M. A., (2008),** Linear Functional Analysis, 2nd edition, **Springer.**
4. **Siddiqi, A. H., (2004),** Applied Functional Analysis, **Marcel-Dekker, New York.**

SEMESTER - II

Course Title	Abstract Algebra with Applications	Maximum Marks	100
Course Code	MS-233	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives …...................		The main objective of this course is to introduce students to the fundamentals of abstract algebra- group and ring theory with their applications to coding theory.
UNIT 01	Class equation and Sylow's theorem with applications	Conjugate of an element of a group; class equation and its applications - non-triviality of centre of a group of order pn, Cauchy's theorem; number of a conjugate classes in S_n; 1st part of Syllow's theorem (Proof by induction); 2nd and 3rd parts of Syllow's theorem(Proofs not included); Applications of Syllow's theorem in the determination of simplicity of groups of order 72, 20449, 225, 30, 385, 108, p2q (p,q primes) and 60.
UNIT 02	Ring theory	Definition and examples of rings; special classes of rings – integral domain, field; characteristic of an integral domain; Homomorphism; ideals and quotient rings; maximal ideals; the field of quotient of an integral domain.
UNIT 03	Euclidean rings	Euclidean ring (ER); ideals in a ER; principle ideal ring; concept of division, gcd, units, associate and prime elements in a ER; relation between prime elements and maximal ideals in a ER; ring of Gaussian integers and ring of polynomials F[x], F a field as examples of ERs.
UNIT 04	Polynomial Rings and UFD	Polynomials over the rational field; primitive polynomials; content of a polynomial; Gauss lemma; Einstein's criteria; polynomial rings over commutative rings; UFD and its relation with ER; R[x] as a UFD when R is a UFD; relation between PIR and UFD.
UNIT 05	Algebraic coding theory:	Classification, structure and subfields of a finite field; Linear codes; Hamming distance and weight with properties; correcting capability of a linear code; orthogonality relation; Parity check matrix decoding; coset decoding; syndrome.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1 Class equation with applications, Cauchy theorem, Syllow's theorems with applications to find simplicity of a group.

2 The concept of ring with standard examples, different classes of rings such as Integral domain, field, ideal and quotient ring.

3 The concept of ideal with standard examples, maximal and prime ideals and quotient field of an Integral domain.

4 The concept of Unique factorization domain, Euclidean ring and Principal Integral domain and relation between them.

5 The concept of Ring of Gaussian integers and polynomials with properties.

6 Gauss lemma and Einstein's criteria.

7 the characterization of subfields of a finite field.

8 The concept of linear code, Hamming distance, coding, decoding, and syndrome.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Gallian, J. A. (1998),** Contemporary Abstract algebra, **Fourth edition**, **Narosa**.

2. **Herstein, I.N,(2004),** Topics in Algebra, 2nd edition, **Wiley.**

REFERENCE BOOKS

1. **Artin, M., (2010),** Algebra, 2nd edition, **Springer**.

2. **Farmer, D.W., (1963),** Groups and Symmetry: A Guide to Discovering Mathematics, **American Mathematical Society.**

3. **Jacobs, H. R., (1979),** Elementary Algebra, 1st edition.

4. **Levinson, N., (1970),** Coding Theory: A Counter Example to G. H. Hardy's Conception of Applied Mathematics, AMS Monthly 77: 249-258

SEMESTER - II

Course Title	Complex Analysis with Applications	Maximum Marks	100
Course Code	MS-234	University Examination	60
Credits	4	Sessional Assessment	40
		Duration of Exam.	3 HOURS

Objectives ….................		The objective of this course is to introduce students to the fundamentals of Complex analysis (with applications) which is a tool with remarkable and almost mysterious utility in applied mathematics.
UNIT 01	Complex Functions	Functions of complex variables, Limit and continuity, Derivative of a complex function and its basic properties; analytic and harmonic functions; C-R Equations; Exponential, Trigonometric and Hyperbolic functions; Logarithmic function; Complex exponents.
UNIT 02	Integral of a complex function-I	Contour integral and its basic properties; ML-inequality; primitives; Cauchy-Goursat theorem; winding number; Cauchy's integral formula; Derivative of an analytic function; Morera's theorem.
UNIT 03	Integral of a complex function-II	Cauchy's inequality; Liouville's theorem; Fundamental theorem of Algebra; Convex Hull; Gauss theorem; Luca's theorem; Gauss mean value property; Max./Min. Modulus principle.
UNIT 04	Series Expansion	Power series; Taylor's theorem; Zeros of an analytic function; Laurent series; Parseval's formula; Reflection principle; Removable singularities, Poles and Essential singularities; Riemann's theorem on removable singularities.
UNIT 05	Calculus of Residues	Residues; Cauchy Residue theorem; connection between zeroes and poles; Argument principle; Casorati-Weirstrass theorem; Rouche's theorem; Evaluation of Definite integrals.

COURSE OUTCOMES

On successful completion of this course, we expect that a student

1. Explain the concept of derivative of a complex function with its basic properties, analytic function, Cauchy Riemann equations.
2. Explain in detail the elementary complex functions such as exponential, trigonometric, hyperbolic, logarithmic, etc.
3. Describe contour integral, convex hull, open convex sets, simple connected domains & winding number etc.
4. Provide the proof of theorems like Cauchy-Gourset theorem, Cauchy integral formula, Cauchy inequality, Morera's theorem, Liouville's theorem, fundamental theorem of Algebra, maximum, minimum modulus theorem, reflection principle etc.
5. Differentiate between isolated and non- isolated regularities, zeroes and poles and should be able to find residues.
6. Explain the theorems like Riemann theorem, Residue theorem, Casorti Weirstrass theorem, argument principle, Hurwitz theorem, Riemann mapping theorem etc.
7. Find real integrals by using complex analysis techniques and construction of harmonic functions.

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 10 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 10 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 10 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Kasana, H. S., (2012),** Complex Variables, Theory and Applications, 2nd Edition, **PHI learning Private limited, New Delhi-110001.**

2. **Ahlofrs, L. R., (1996),** Complex Analysis, **McGraw Hill.**

3. **Ponnusamy, S., (1972),** Foundation of Complex Analysis, 2nd edition, **Narosa Publishing House.**

REFERENCE BOOKS

1. **Brown, J. W. and Churchill, R. V., (2009),** Complex Variables and Applications, 8th Edition, **McGraw-Hill International.**

2. **Conway**, **J. B., (1973),** Functions of one Complex Variable, 2nd edition,**Springer International Student edition.**

3. **Rudin, W., (1987),** Real and Complex Analysis, 3rd edition, **McGraw Hill International Edition**.

4. **Mathews, J. H. & Howell, R. W., (2006),** Complex Analysis for Mathematics and Engineering, 5th edition, **B Jones and Bartlett Publishers .**

SEMESTER - II

Course Title	Elements of Accountancy	Maximum Marks	50
Course Code	MS-235	University Examination	30
Credits	2	Sessional Assessment	20
		Duration of Exam.	2 HOURS

Objectives ………………..		The objective of this course is to introduce students to the fundamentals of Complex analysis (with applications) which is a tool with remarkable and almost mysterious utility in applied mathematics.
UNIT 01	Accounting	Meaning, objectives, need, development and importance of accounting, definition and functions of accounting, nature and scope of accounting, process of accounting cycle, difference between accounting and book keeping.
UNIT 02	Financial accounting	Nature and scope of financial accounting; basic Accounting terms - business transaction, capital, drawings, assets, liability, revenue, expenditure, expense, income, purchases, sales, stock, debt, credit, receivables, payables, accounting equation, types of accounts.
UNIT 03	Basic assumptions of Accounting	Accounting entity, money measurement, going concern concept, accounting period concept; basic principles of accounting - objectivity, full disclosure, matching principle, historical cost, Revenue recognition and quality principle.

COURSE OUTCOMES

On successful completion of this course, we expect that a student have understood

1 objectives, need, development and importance of accounting.

2 nature and scope of financial accounting.

3 basic Accounting terminology.

4 basic principles of accounting

Note for Paper Setting

The question paper will be divided into two sections. Section A will be compulsory and will contain 06 very short answer type questions eliciting answers not exceeding 20 words/ multiple choice questions/ fill in the blanks, each carrying one mark equally distributed from all units. Section B will contain 06 long answer type questions, two from each unit and the candidate will be required to answer one from each unit. Each question carries 08 marks.

BOOKS RECOMMENDED

TEXT BOOKS

1. **Beams F.A, "Advanced Accounting".**

REFERENCE BOOKS

1. **Dearden J and S.K. Bhattacharya**, "Accounting for Management".
2. **Gupta. R. L,** "Advanced Financial Accounting".
3. **Monga. J. R,** "Advanced financial Accounting".

SEMESTER - II

Course Title	MatLab	Maximum Marks	50
Course Code	MS-236	University Examination	25
Credits	2	Sessional Assessment	25
		Duration of Exam.	2 HOURS

Objectives .... The Lab course has been designed to train students of Mathematics in using MatLab and computers in evolving solutions to problems of Numerical Analysis and linear algebra.

* Each student is required to maintain a practical record book.

* Two practical tests, one Internal and one External, are to be conducted.

* Each practical test will be of 25 marks.

* The marks in each practical test will be divided into 4 parts, program code, program execution , Viva-Voce and practical record book.

* The student has to pass both internal and external practical tests separately scoring a minimum of 10 marks in each test

COURSE OUCOMES

On successful completion of this course, we expect that a student have understood

1 the applicability of MATLAB in Mathematics in particular and engineering applications in general.

2 the commands of MATLAB which one uses to solve elementary problems of numerical Analysis.

3 the concept of M-file and Script file along with control flow programming.

4 the plotting of graphs of functions by using syntax and semantics.