

COURSES OF STUDIES

PRIVATE EXAMINATION



Sambalpur University

MA PART - I

2015

Mathematics

Published by

PRIVATE EXAMINATION CELL

SAMBALPUR UNIVERSITY

Jyoti Vihar, Sambalpur

(Odisha)

PART - II

A. GROUPS AND LINEAR ALGEBRA

- Unit-I Review of Group Theory : Groups, Subgroups, Normal Subgroups, Quotient groups, Homomorphism, Isomorphism, Cyclic Groups, Permutation Groups, Symmetric Groups, Cayley Theorem.
- Unit-II Direct Products, Series of groups, Group Action on a set, Sylow theorem, Application of Sylow theorem, Free Abelian groups, Free Groups.
- Unit-III Vector Spaces, Subspaces, Quotient spaces, Linear independence, Bases, Dimension, Projection, Algebra of Matrices, Rank of a matrix, Characteristic roots and Vectors.
- Unit-IV The Algebra of Linear transformation, Kernel, Range Matrix representation of a linear transformation, Change of bases, Linear functionals, Dual space, Eigen values, Eigen vectors, Cayley-Hamilton theorem, Canonical Forms: Diagonal forms, Triangular form, Jordan form, Quadratic form, Inner product spaces.

Book for Reference :

- 1) I.N. Herstein : Topics in Algebra, Vikas Publication.

MATH MATICS

SCHEDULE - A

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|-----------|--------------------------------------|-----------|----------|
| Paper-I | A) Real Analysis | (MSM 501) | 50 marks |
| | B) Complex Analysis-I | (MSM 501) | 50 marks |
| Paper-II | Algebra | | |
| | A) Groups and Linear Algebra | (MSM 502) | 40 marks |
| | B) Rings and Fields | (MSM 502) | 60 marks |
| Paper-III | A) Mathematical Methods | (MSM503) | 40 marks |
| | B) Differential Geometry | (MSM 503) | 60 marks |
| Paper-IV | A) Introductory Computer programming | (MSM 504) | 50marks |
| | B) Measure Theory and Integration | (MSM 504) | 50 marks |
| Paper-V | A) Ordinary Differential Equations | (MSM 505) | 50 marks |
| | B) Topology | (MSM 505) | 50 marks |

Detailed Syllabus

PAPER-I

A. REAL ANALYSIS

- Unit-I Sets, Relation, Functions, Axiom of Choice and some of its equivalents, Cardinality, Countability Construction of real numbers.
- Unit-II Topology of \mathbb{R} and \mathbb{R}^n , Convergence, Continuity, uniform continuity,

Differentiability, Functions of bounded variations, Riemann-Stieltjes Integral.

Unit-III Convergence of Sequence of functions, Uniform convergence, Improper Integral, Weierstrass Approximation Theorem.

Unit-IV Differentiation in \mathbb{R}^n , Partial Derivative, Jacobian, Multiple Integrals, Inverse Function Theorem, Implicit Function Theorem.

The Course is covered by :

- 1) Hewitt and Stromberg : Real and Abstract Analysis, Second Edition, Springer Verlag.
- 2) T. Apostol : Mathematical Analysis, Narosa.
- 3) W. Rudin : Principle of Mathematical Analysis.
- 4) A.R. Shastri : An Introduction to Complex Analysis.

The questions are to be set that no candidate can avoid any of the Units mentioned in this course.

B. COMPLEX ANALYSIS

Unit-I The Complex Number system, the spherical representation, Analytic functions, Power Series, Exponential and trigonometric functions.

Unit-II Conformal mapping, Mobius transformation, Cross-ratio.

Unit-III Riemann-Stieltjes Integrals, Power Series representation of Analytic Functions, The index of a closed curve, Cauchy's theorem for rectangle, Cauchy theorem for disc. Cauchy's integral formula, Liouville's theorem, fundamental theorem of Algebra, Morera's theorem, Open mapping theorem.

Unit-IV Zeros, Poles, Classification of Singularities, Laurent Series, Residues, The Argument Principle, Rouché's Theorem, the Maximum Modulus Theorem, Schwarz's Lemma.

The Course is covered by :

- 1) J.B. Conway : Functions of one Complex Variable, Narosa.
- 2) Lars, V. Ahlfors : Complex Analysis, McGraw Hill.
- 3) E. Titchmarsh : Theory of Functions, Oxford.
- 4) Ponnusvamy : Elementary Complex Analysis, Narosa.
- 5) D.Sarason : Lectures on Complex Function Theory, Hindustan Publishing Company.

Books for Reference :

- 1) Boothby, W.W. : An Introduction to Differentiable Manifolds and Riemannian Geometry, Academic Press.
- 2) Willmore, T. : Introduction to Differential Geometry, Oxford University Press.
- 3) Rudin : Principles of Mathematical Analysis.
- 4) Flanders : Differential Forms, Academic Press.
- 5) Nirmal Prakash : Differential Geometry, Tata McGraw Hill.

PAPER — IV

A. INTRODUCTORY COMPUTER PROGRAMMING

PROGRAMMING WITH FORTRAN

- Unit-1 Arithmetic Statements, Numerical Input and Output, Transfer of Control, do-loops.
- Unit-II Arrays and subscripted variables, Functions and sub-routines, Character information, Logical Variables, Operations, Additional features of input and output.

PROGRAMMING WITH PASCAL

- Unit-III Pascal fundamentals, Scalar type data, Data input and output, Creating and running a Pascal programme.

- 2) J.B. Fraleigh : A first course in Algebra, Narosa.
- I 3) A. Ramachandra Rao and P. Bhimasankaram : Linear Algebra, Tata McGraw Hill.
- 4) P.R. Halmos : Finite Dimensional Vector Spaces.
- 5) Mirsky : Linear Algebra.
- 6) Hoffman & Kunze : Linear Algebra.

B. RINGS AND FIELDS

- Unit-I Review of Ring Theory, Integral domain, Homomorphisms, Ideals, Maximal Ideal, Prime ideal, Quotient rings.
- Unit-II Euclidean rings, Polynomial rings, Principal ideal domain, Unique factorization domain.
- Unit-III Extension fields, Transcendence of e and root of polynomials, Construction with straight edge and Compass.
- Unit-IV More about roots, elements of Galois theory, Solvability by Radicals.

Books for Reference :

- 1) I.N. Herstein : Topics in Algebra, Vikas Publications.
- 2) J.B. Fraleigh : A first course in Algebra, Narosa.
- 3) M. Artin : Algebra, Prentice Hill.

PART - III

A. MATHEMATICAL METHODS

Unit-I Gamma Function, Beta Function, Relation to $\Gamma(x)$, Wallis's product, Stirling's formula, Periodic functions, Trigonometric series, Several Classes of functions, Elementary ideas about Fourier series, Euler Formula.

Unit-II Orthogonal System of functions, Fourier series of a function relative to an orthonormal system, Mean square approximation, Bessel's Inequality, Riemann Lebesgue lemma, Dirichlet Kernel, Convergence theorem, computation of Fourier Series of (a) function having arbitrary period (b) Even and odd functions, Half Range Expansion.

Unit-III Definition of Laplace transform, Properties of the transform, Region of convergence, Resurgent, Inverse, Laplace transform and properties.

The question should be set in such a fashion that every student as to attempt question from each unit. Calculus of variations - Enter Lagrange equation and applications.

Books for Reference :

- 1) Widder, D. : Advanced Calculus, Prentice Hall of India.

- 2) Kreyszig, E. : Advanced Engineering Math, Wiley Eastern Ltd.
- 3) Potter & Goldberg : Mathematical Methods.
- 4) Apostol : Mathematical Analysis, Narosa.
- 5) Gupta, A.S. : Calculus of Variation, Prentice Hall India.

B. DIFFERENTIAL GEOMETRY

Unit-I Review of Calculus in R^n , Inverse and implicit function theorems, Rank Theorem, Introduction to manifolds, Differentiable manifolds, Examples, Sub-manifolds, tangent vectors and tangent space at a point of the manifold, vector fields.

Unit-II Multi linear Algebra, (Dual space, tensor type (r, s) , operations with tensors, contraction, Metric tensor, associated tensors, symmetric and anti-symmetric tensors, Exterior algebra, Tensor fields, Exterior derivative.

Unit-III Riemannian Manifolds, Riemannian Metric, Covariant Differentiation, Affine Connection, Levi, Civita Connection, Curvature, Parallel Transport, Fundamental Theorem of Riemannian Geometry, Bianchy Identities, Scalar Curvature.

Unit-IV Integration on Manifolds, Stokes theorem, Definition and examples of Lie groups and Lie Algebra, Some Applications of Riemannian Geometry to general relativity.

- 2) Coddington & Levinson : Ordinary Differential Equations.
- 3) Tya-Myint-U : Ordinary differential Equations.
- 4) L.Elsgolts : differential Equations & Calculus of variations, Mir Publication.

B. TOPOLOGY

- Unit-I Basic concepts of Topology, Examples, Bases, Sub-bases, Contability, closed sets, Limit Points, Continuous functions.
- Unit-II New Topologies from Old :- Subspace topology, product topology, Quotient topoloty.
- Unit-III Connectedness, Local connectedness, Path-connectedness, compact Spaces, Compactness in metric spaces, locally, compact spaces,
- Unit-IV T_1, T_2 - axioms, Regular and completely regular space, normal spaces, Urysohn Lemma.
- Unit-V Tychonoff Theorem, Homotopy equivalences, Fundamental Group of a space, Fundamental Group of S.

Book for Reference :

- 1) J. R. Munkres : Topology - a first course in Topology. 2) Dugundji : Topology. 3) Kelly : General Topology.

Unit-IV Control Structure, Procedure and Function.

Unit-V Arrays and Records.

Books for Reference :

- 1) Lip Schutz and Poe : Theory and Problems of Programming with Fortran Schaum Outline Series.
- 2) Fortran 77 and Numerical Methods, C. Xavier, Wiley Eastern Ltd.
- 3) Fortran 77: A structured, Disciplined style, Davis and Hoffman, Tata McGraw Hill. α
- 4) Gottfried : Theory & Problems of Programming with Pascal, Schaum Outline Series.

B. MEASURE AND INTEGRATION

- Unit-I Lebesgue Outer Measure, Measurable sets, Measurable functions, Boorel and Lebesgue measurability, a non-measurable set, simple functions, Integration of non-negative functions, The general Lebesgue Integra.
- Unit-II Differentiation of monotone functions, Lebesgue Differentiation theorem. Absolute continuity, Differentiation and Integration.
- Unit-III Measures and oute measures, Extension of a measure, completion of a measure,

Measure spaces, Measurable functions, Integration with respect to a measure and its properties, Monotone Convergence Theorem, Dominated convergence theorem, Fatou's Lemma, convergence in measure.

Unit-IV Complex and signed measures and the Hahn decomposition, Jordan decomposition, Radon Nikodym theorem, Measurability in a product space, Product measure and Fubini theorem, Elementary ideas about L^p -Spaces.

N.B. : The questions shall be put in such a way that student has to attempt questions from every unit.

Books for Reference :

- 1) DeBarra, G. : Measure Theory and Integration, Willey Eastern.
- 2) Royden, R. : Real Analysis, The Macmillan . Company.
- 3) Rudin, W. : Real and Complex Analysis, Tata McGraw Hill.
- 4) Hewitt and Stromberg : Real and Abstract Analysis, Springer/ Narosa.

PAPER - V

A. ORDINARY DIFFERENTIAL EQUATIONS

- a) Quick Review of Linear Differential Equations of Higher Order, Wronskian.

Unit-I System of Linear Differential Equations : System to first order equations, Existence and Uniqueness theorems, Fundamental Matrix, Non-Homogeneous linear Systems, Linear Systems with Constant Co-efficients, Linear Systems with Periodic co-efficients.

Unit-II Existence and Uniqueness of Solutions : Successive approximation, Picard's Theorem, Non-uniqueness of solutions, Continuation and dependence on Initial conditions, Existence of solutions in the large, Existence and uniqueness of solution of systems.

Unit-III Oscillations of Second Order Equations : Fundamental Results, Sturm's Comparison Theorem, Elementary linear Oscillation, Comparison theorem of Hille Winter Oscillations of $X'' + a(t)x = 0$.

Unit-IV Boundary Value Problems : Introduction, Sturm Liouville Problem Green's Functions, Picard's theorem. The course is covered by Ch. 2, (Quick Review) 4,5,6,7, of "Ordinary differential Equations and Stability Theory" by S. G. Deo and V. Raghvendra, TATA Mc Graw Hill Ltd.

Book for Reference :

- 1) G. Birkhoff & G. C. Rona : Ordinary Differential Equations, John Wiley & Sons, N.Y.