# Pt. Ravishankar Shukla University, Raipur
# M.Phil. (Mathematics)
# 2014-15 & Onward

## Scheme of Examination

There shall be three theory papers, one dissertation and one seminor based on theory in M.Phil.(Mathematics). All are compulsory. Each theory paper will have 100 marks. The course content of each paper has been divided into five units. However, there will be internal choice in each Unit. Dissertation will be of 150 marks ((Script -75+Ext. -50+ Viva -Voce 25). Seminar –based on theory will be of 50 marks.

| S.No. | Particulars | | | Max. Marks | |
|---|---|---|---|---|---|
| 1 | Theory Papers | Paper-I | Research Methodology, Quantitative techniques and Computers (Code 101) | 100 | 300 |
| | | Paper-II | Cryptography (Code 102A) **OR** Mathematical Modelling (Code 102B) | 100 | |
| | | Paper-III | Nonlinear Analysis and Topological Structures (Code 103) | 100 | |
| 2 | Seminar | | Based on Theory | 50 | 50 |
| 2 | Dissertation | | Script | 75 | 150 |
| | | | Ext. | 50 | |
| | | | Viva-Voce | 25 | |
| Grand Total | | | | | 500 |

Guidelines of activities/academic calendar for M.Phil. Students:

1. In order to pass the M.Phil. Examination a student required to obtain a minimum of 25% marks in each theory paper and minimum of 50% marks in aggregate to the theory papers, dissertation and seminars separately.
2. The subject of dissertation will be provided by supervisor in the first week of September.
3. The dissertation has to be submitted by the end of first week of March. Thereafter supervisor will take no responsibility for delay in the submission of the dissertation.
4. Students are requested to complete the typing work (preferably in AMS-Tex/Latex) of their dissertation by the last week of February.
5. Every week on student will present his/her seminar using OHP/LCD based on the theory papers/on the subject assigned in the dissertation.

# Details of Syllabus

## Paper I
## Research Methodology, Quantitative techniques and Computers

**M.M. 100**

**Unit I – Research Methodology:**
Introduction to research methodology, Meaning, objectives, types, significance of Research. Identification, Selection of Research problem, Formulation of research objectives, Research design, components, importance and typology, Quantitative and qualitative methodology, hypotheses. Research ethics.

**Unit II - Scientific Writing :** Importance of Science Writing , Meaning and nature of Scientific Style , Writing effective scientific prose, Effective word selection in Science writing, Common mathematical functions and their abbreviations, Symbols, Operators Commonly used in Mathematics, Greek, Roman letters used in mathematics, Mathematical Theorems and properties, Mathematics Journals and their abbreviations.

**Unit III - Style and Usage for Mathematics :**
**Review :** Mathematics Subject Classifications (MSC). Mathematical Review, MathSciNet and other E-Resources.

**Manuscript Preparation** :
Structure of a Standard Mathematics Paper (in brief), Other Forms of Mathematics Manuscripts.

**Usage :** Mathematical Expressions, Alphabets used in Mathematical Expressions, Bracketing, Limits, Fractions, Multiplication, Vectors, Tensors, and n-forms, Summations, Products, Unions, and Integrals.

**Unit IV - Typesetting Mathematical Text** :
Sample Document, Type Style, Environments, Lists, Centering,Tables, Verbatim, Vertical and Horizontal Spacing. Equation Environments, Fonts, Hats, and Underlining, Braces, Arrays and Matrices, Customized Commands, Theorem-like Environments, Math Styles, Document Classes and the Overall Structure, Titles for Documents, Sectioning Commands, Packages, Inputting Files, Inputting Pictures, Making a Bibliography, Making an Index, Slides.

**Unit V - MATLAB :**
Arithmetic Operations, built-in-MATH functions, scalar variables, Creating Arrays, built-in-functions for handling arrays, Mathematical Operations with Arrarys, Script Files, Two dimensional plots, programming in MATLAB, Polynomial, curve fitting, and interpolation, Three-dimensional plots.

**Books recommended :**


1. C.R.Kothari, Research Methodology, New Age International Publishers (2004)
2. Michael Davis : Ethics and the University. Routledge (1999)
3. Harold Rabinowitz, Suzanne Vogel : The Manual of Scientific Style. Academic Press (2009)
4. Laslie Lamport : LATEX. Addison Wesley Publication Company (1994)
5. David F. Griffiths, Desmond J. Higham : Learning LATEX. Society for Industrial and Applied Mathematics, Philadelphia (1997)
6. Amos Gilat : MATLAB : An Introduction with Applications. John Wiley & Sons, INC (2004)

# Paper –II(A)

# Cryptography

**M.M. 100**

**Unit I :Fundamental concepts**:
Elements of number theory: Greatest Common Divisor, divisibility and Euclidean algorithm, Congruences, Semi-Groups, Groups, Residue Class Rings, Fields, Analysis of Operation in the Residue Class Rings, Fermat's Little Theorem, Fast Exponentiation, The Chinese Remainder Theorem ,Time estimates for doing arithmetic, Polynomial time. Factoring concept.

**Unit II – Encryption process** :
Encryption, decryption and key generation. Symmetric and Asymmetric Crypto systems, Cryptanalysis, Alphabets and Words, Permutations, Block Ciphers, Multiple Encryption, Use of Block Ciphers, Stream Ciphers, Affine Ciphers, Matrices and Linear Maps, Affine Linear Block Ciphers, Vigenere, Hill and Permutation Ciphers, Cryptanalysis of Affine Linear Block Ciphers

**Unit III - Public key cryptosystems :**
Probability and perfect secure, Various One Time Rabin System, ElGamal System, Enciphering matrices, the idea of public key cryptography, design of RSA, some important properties of RSA, Discrete logarithm problem, public key cryptosystem based on Knapsack problem , the concept of zero knowledge transfer.

**Unit IV - Primality and factoring:**
Trial Division, Carmichael number, Millor-Rabin Test, p-1 Method, pseudo primes, the rho methods, Fermat factorization and factor basis, the continued fraction method, the quadratic sieve method.

**Unit V- Elliptic curves :**
Basic facts and application of elliptic curve in cryptography, elliptic curve cryptosystem, elliptic curve primality test, elliptic curve factorization. Digital Signatures: RSA Signature, Signature from Public Key Systems, ElGamal Signature.

**Books recommended :**
1.A course in number theory and cryptography by N. Koblitz. Springer 2002.
2.An introduction to cryptography by J. A. Buchmman. Springer.2001.
3.Introduction to Cryptography by Hans Delfs and H.Knebl. Springer 2001.
4. Modern cryptography by O.Goldrich. Springer. 1999
5. Modern cryptography: theory and practice by Wenbo Mao. HP. 2004.

# Paper –II(B)

## Mathematical Modelling

**M.M. 100**

**Unit I - Unstructured Population Models in Continuous Time:**

Modelling population dynamics : Describing a population and its environment , The population or p-state, The individual or i-state , The environmental or E-condition,

Population balance equation, Characterizing the population, Population-level and per capita rates, Model building, Exponential population growth, Logistic population growth, Two-sexes population growth, Parameters and state variables, Deterministic and stochastic models

**Unit II - Single ordinary differential equations:**

Explicit solutions, Numerical integration, Analyzing flow patterns, Steady states and their stability , Units and non-dimensionalization, Existence and uniqueness of solutions, Epilogue

**Unit III – Dynamics of Class:**

Structured Populations , Introduction , Constructing Class-Structured Models , Analyzing Class-Structured Models , Reproductive Value and Left Eigenvectors , The Effect of Parameters on the Long-Term Growth Rate, Age-Structured Models--The Leslie Matrix,

**Unit IV – Equilibria and Stability Analyses--One-Variable Models** :

Introduction , Finding an Equilibrium, Determining Stability, Approximations. **General Solutions and Transformations--One-Variable Models,** Introduction, Transformations, Linear Models in Discrete Time, Nonlinear Models in Discrete Time, Linear Models in Continuous Time, Nonlinear Models in Continuous Time.

**Unit V - Traffic Flow:**

History and scope of traffic flow theory, Model classification, Non-motorized Traffic, Traffic density and hydrodynamic flow-density relation, continuity equation for several Road profits, continuity equation from the driver's perspective, Lagrangian description. Model based Traffic Flow Optimization: Basic principle, speed limit, Ramp routing, Dynamic routing, efficient driving behaviour and adaptive cruise control, Further local traffic regulation, objective functions for Traffic Flow Optimization.

**Books recommended :**


1. A Biologist's Guide to Mathematical Modeling in Ecology and Evolution, Sarah P. Otto and Troy Day.
2. Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow, Richard Haberman.
3. Traffic Flow Dynamics: Data, Models and Simulation, Martin Treiber, Arne Kesting, Christian Thiemann
4. Human Behaviour and Traffic Networks, Michael Schreckenberg, Reinhard Selten

# Paper III

# Nonlinear Analysis and Topological Structures

**M.M. 100**

**Unit I Calculus in Banach spaces :**
Various forms of continuity, geometry in normed spaces and duality mapping, Nemytskii, hammerstein and Uryshon operators, Gateaux and Frechet derivatives , properties of the derivative, Taylor's theorem, inverse function theorem and implicit function theorem.

**Unit II Monotone operators and its applications :**
Monotone operators, surjectivity theorems, constructive solutions of operator equations, subdifferential and monotonocity, generalizations of monotone operators.

**Unit-III Dynamical Systems, Manifolds and Complexes:**
The role of topology in Chaos and dynamical systems- *History of Chaos, examples, notions of Chaos.* Identification spaces and compactness. Cantor sets. Application of compact sets in *population dynamics and Fractals,* Manifolds. Triangulations. Classification of surfaces. Euler Characteristics. Topological groups. Group actions and Orbit spaces. Application of manifold in Robotic coordination and configuration spaces, geometry of manifolds, the topology of the Universe.

**Unit-IV Homotopy, Winding Numbers and Vector Field**:
Homotopy and paths. The winding number. Degrees of maps. The Brouwer fixed point theorem. The Borsuk-Ulam Theorem.. Vector fields and the Poincare Index Theorem. Applications in the fundamental theorem of algebra, Sandwiches, Game theory and Nash equilibria, Vector fields, Path integrals and the winding number, Vector fields on surfaces, Index theory for n-symmetry fields.

**Unit-V The Topological Degree:**
Axiomatic Definition of the Brouwer Degree in $\mathbf{R}^n$. Application of the Brouwer Degree. Brouwer Theorem, Perron-Frobenius Theorem, Surjective Maps, Hedgehog Theorem. The Leray-Schauder degree. Borsuk's Antipodal Theorem. Compact Linear Operators. Application of topological degree in *Fixed Point Theory.*

## Books recommended :


1. M. C. Joshi and R. K. Bose, Some topics in nonlinear functional analysis, Wiley Eastern Limited, New Delhi 1985.
2. E. Zeidler, Nonlinear functional analysis and its applications I: Fixed Point Theorems, Springer, Heidelberg 1986.
3. K. Deimling, Nonlinear functional analysis and its applications I: Fixed Point Theorems, Springer, Heidelberg 1985.
4. William F. Basener, Topology and its applications, Wiley-InterScience, 1973.
5. R. Akerkar, Nonlinear functional analysis, Narosa Publishing House, New Delhi.
6. C. Robinson, Dynamical Systems, Stability, Symbolic Dynamics and Chaos, CRC Press, 1995.
7. S. Willord, General Topology, Dover, 2004.
8. R. L. Devancy, An Introduction to Chaotic Dynamical Systems, Persues Publicating Co., 1989.