UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

M.Phil. in Mathematics

Semester Scheme

Examination 2019-2020
Scheme of Examination: One Semester
(July to October—teaching and examination in November)

There shall be four papers in all. Two papers are compulsory and two papers are elective.

3 hrs duration Each Theory paper and dissertation Max. Marks — 80
Internal assessment Max. Marks — 20
Total Marks — 100
(for each four papers)

Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate.

Semester — I is common for both Ph.D. and M.Phil. students.

Teaching Pattern:
Self study with guidance from a Faculty Member, who will act as Supervisor. To start
with, each Supervisor will give one seminar lecture to all the students offering the paper
so as to provide a model to the students.

For Semester — I, the papers are as follows:

Paper — I: Research Methodology
Paper — II: Analysis of Published Research Paper
(A short dissertation is to be submitted by each student under the
supervision of a faculty member)

Each student has to opt two papers out of the following
Papers III to IX:

Paper — III: Advanced Numerical Analysis
Paper — IV: Generalized Hypergeometric Functions and Fractional Calculus
Paper — V: Operations Research-I
Paper — VI: Mathematical Modelling and Perturbation Methods
Paper — VII: Integral Transforms and Advanced Tensor Analysis
Paper — VIII: Advanced Graph Theory-I
Paper — IX: Relativistic Cosmology and Differential Forms

Note:

1. There will be four hour teaching in a week per paper including dissertation.
2. For a pass in course work for Ph.D. and M.Phil. course a candidate shall be
required to obtain (a) at least 40% marks in each paper separately in internal
assessment and external assessment and (b) a minimum of 50% marks in
aggregate of all the papers prescribed for the examination (internal and external
assessment taken together).

[Signature]
Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR
Paper - I : Research Methodology

3 hrs. Duration Theory Paper Max. Marks : 80
Internal Assessment Max. Marks : 20

(Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate).

Note: This paper is divided into Four Units. Two questions will be set from each Unit.
Candidates are required to attempt FOUR questions in all taking one question
from each Unit. All questions carry equal marks.

Unit I: Concept of Research, Types and approaches, Ethics in Research, Types and
Methods of Research, Report Writing, The First Draft, title page, table of contents,
headings and sub-headings, footnotes, tables and figures, appendix, References etc.

Unit II: Plagiarism checking, Editing, Post Writing Stage, Elements of Thesis, Title
Page, Table of Contents, Proof Reading, Use of Computer in Research, Use of technology
and other equipments in Research.

Unit III: Preparation of Power Point Presentation. Introduction to UGC INFONET,
INFLIBNET and ERNET etc. Writing a Research Paper. Choosing a Topic.

Unit IV: Preparing a Working Bibliography, Use of available Computer Softwares and
tools in Research

Paper - II : Analysis of Published Research Paper
(A short dissertation is to be submitted by each student under the
supervision of a faculty member)

Dissertation Evaluation (External) Max. Marks : 80
Internal Assessment Max. Marks : 20

(Internal Assessment will be done by the supervisor concerned on the basis of the
performance and aptitude towards research of the candidate)

Paper - III: Advanced Numerical Analysis
3 hrs. Duration Theory Paper Max. Marks : 80
Internal Assessment Max. Marks : 20

(Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit.
Candidates are required to attempt FOUR questions in all taking two questions
from each Unit. All questions carry equal marks.

Unit 1: Errors – Errors in Numerical Calculation, Numbers and their accuracy, Errors and
their analysis, General error formula, Error in a series approximation, Number
representation. Numerical Solutions of Integral Equations – Integral equations, Fredholm
integral equation, Finite difference methods, Chebyshev series method, Method using
generalized quadrature, Method for degenerate kernels.

Paper - IV: Generalized Hypergeometric Functions and Fractional Calculus
3 hrs. Duration Theory Paper Max. Marks - 80
Internal Assessment Max. Marks - 20

(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit 1: Generalized hypergeometric function - Definition, Convergence of the series \( \Phi_\nu \). Differential equation and its solution. Conjugate function relations. Saalschutz's theorem, Whipple's theorem, Dixon's theorem. Contour integral representation for \( \Phi_\nu \). Eulerian type integrals involving \( \Phi_\nu \). Integral representation for \( \Phi_\nu \).


Paper - V: Operations Research-I
3 hrs. Duration Theory Paper Max. Marks - 80
Internal Assessment Max. Marks - 20

(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit 1: Theory of Games – Basic definitions. Saddle point. Optimal strategies and the value of game. Fundamental theorem of game theory. 2x2 games: without saddle points. Graphical method for 2x2 and mx2 games. Inventory Models – Definition, elementary inventory models e.g. EOQ model without and with shortages and EOQ with constraints.

Unit 2: Replacement and Reliability Models – Replacement of items that deteriorate, Replacement of items that fail completely and other replacement problems. Queueing Theory – Definition, Queueing system. Arrival distribution theorem, Distribution of departures, Probabilistic queueing models – Models I to IX; Mixed queueing models – Model X; Deterministic queueing model – model XI.

Raj

Dy. Registrar
Paper-VI: Mathematical Modelling and Perturbation Methods
3 hrs. Duration  Theory Paper  Max.Marks-80
Internal Assessment  Max.Marks-20
(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).
Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit - I: Perturbation Methods

Unit - II: Mathematical Modelling

Paper-VII: Integral Transforms and Advanced Tensor Analysis
3 hrs. Duration  Theory Paper  Max.Marks-80
Internal Assessment  Max.Marks-20
(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).
Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit - I: Integral Transforms

Unit - II: Advanced Tensor Analysis
Generalized Kronecker delta, Krutkov tensor, Ricci rotation. coefficients and geometrical properties, Hypersurface, Gauss formulae, Curvature of a curve in a hypersurface, normal curvature of a hyper surface, Conformal invariance, classification of gravitational field,
Space-matter tensor, Conharmonic curvature tensor, Conharmonically flat space, Symmetry, Maximally symmetric space, spherical, plane and cylindrical symmetries.

Paper-VIII: Advanced Graph Theory-I
3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20

(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit-I:
Graphic sequences, The Petersen graph, Cayley's formula, Matrix tree theorem, Matchings, Maximal and maximum matchings, Alternating and augmenting paths, Hall's matching condition, Marriage theorem, Vertex and edge covers, Independent sets, Algorithm for computing maximum bipartite matching, Planar embeddings, Planar graphs, Dual graphs, Outerplanar graphs.

Unit-II:
Line Graphs - Some properties of line graphs, Characterization of line graphs, Special line graphs, Line graphs and traversability. The automorphism group of a graph, Operation on Permutation groups, The group of a composite graph, Graphs with a given group, Symmetric graphs.

Paper-IX: Relativistic Cosmology and Differential Forms
3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20

(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit 1:
Lie derivative of a Tensor field, Scalar function, Contravariant and covariant vectors. Covariant tensor of rank two, Symmetry and killing equations, Integrability of killing equation, Geodesic deviation, Conformal curvature tensor, its properties, Algebraic classification of conformal curvature tensor.

Unit 2:
Basic equations of isotropic cosmology, singularity and Singularities in isotropic models, Red Shift in non-static form of de-Sitter universe, Einstein-space, Cosmological principles (perfect, ordinary and weak), Relativistic models not obeying cosmological principle, Godel universe and its properties.
M.Phil. Mathematics Examination

Scheme of Examination: Two Semesters
(July to October teaching and examination in November for Semester - I)
and December to March teaching and examination in April, for Semester - II)

For Semester - I teaching is common for both Ph.D. and M.Phil. students.
(Papers, Syllabus and Scheme of Examination are also common)

For Semester - II

<table>
<thead>
<tr>
<th>Max. Duration</th>
<th>Theory Paper</th>
<th>Max. Marks: 80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal Assessment</td>
<td>Max. Marks: 20</td>
</tr>
</tbody>
</table>

(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularly in the class and performance of the Candidate). 

Dissertation | Max. Marks: 100

Teaching Pattern:
Self study with guidance from a Faculty Member, who will act as supervisor. To start with, each Supervisor will give one seminar lecture to all the students offering the paper so as to provide a model to the students.

For Semester - II, the papers are as follows:

Paper - I: Advanced Mathematical Analysis
Paper - II: Analysis of Published Research Paper
(A short dissertation is to be submitted by each student under the supervision of a faculty member)

Each student has to opt two papers out of the following

Papers III to VIII:

Paper - III: Advanced Numerical Analysis
Paper - IV: Generalized Hypergeometric Functions and Fractional Calculus
Paper - V: Operations Research-II
Paper - VI: Non-Newtonian Fluid Dynamics
Paper - VII: Advanced Graph Theory-II
Paper - VIII: Relativistic Cosmology and Differential Forms

Note:
1. There will be four hour teaching in a week per paper including dissertation.
2. For a pass in course work for Ph.D. and M.Phil. course a candidate shall be required to obtain (a) at least 40% marks in each paper separately in internal assessment and external assessment and (b) a minimum of 50% marks in aggregate of all the papers prescribed for the examination (internal and external assessment taken together).
Note: Paper I and II are compulsory and two papers out of the papers III to VIII will remain the same which the candidate opted in Semester-I.

**Paper – I : Advanced Mathematical Analysis (Compulsory for all candidates)**

<table>
<thead>
<tr>
<th>3 hrs. Duration</th>
<th>Theory Paper</th>
<th>Max. Marks-80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal Assessment</td>
<td>Max. Marks-20</td>
</tr>
</tbody>
</table>

(Note: Internal Assessment will be done by the teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate.)

Note: This paper is divided into Four Units. Two questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking one question from each Unit. All questions carry equal marks.

**Unit 1:**

**Unit 2:**
Sylow's theorem, Semigroup, Semigroup of relations on a set of Congruences, Factor groupoids and homomorphisms, Homotopy Type, The Fundamental Group, Covering Spaces.

**Paper – II : Dissertation :**
Each candidate has to submit a dissertation, based upon the papers opted by the candidate in M.Sc./M.Phil. Course, equal to a paper carrying 100 marks

<table>
<thead>
<tr>
<th>External Evaluation</th>
<th>Max. Marks-100</th>
</tr>
</thead>
</table>

**Paper – III: Advanced Numerical Analysis**

<table>
<thead>
<tr>
<th>3 hrs. Duration</th>
<th>Theory Paper</th>
<th>Max. Marks-80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal Assessment</td>
<td>Max. Marks-20</td>
</tr>
</tbody>
</table>

(Note: Internal Assessment will be done by the teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate.)

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

**Unit 1:**
Explicit three level difference scheme, Implicit scheme. First order hyperbolic equation –
Lax – Wendroff formula.

Unit 2:
Finite Element Methods – Introduction. Weighted residual methods, Variational
methods, Rayleigh-Ritz method, Galerkin method. Finite elements, Assembly of element
equation. Application of finite element method. One-dimensional and two-dimensional
problems.

Paper – IV: Generalized Hypergeometric Functions and Fractional Calculus
3 hrs. Duration Theory Paper Max.Marks-80
Internal Assessment Max.Marks-20

(Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit.
Candidates are required to attempt FOUR questions in all taking two questions
from each Unit. All questions carry equal marks.

Unit 1:

Unit 2:
H-function of one variable – Definition. Identities Special cases Differentiation
formulas. Recurrence and contiguous function relations. Finite and infinite series Fourier
series for the H-function. Simple finite and infinite integrals involving the H-function.
Paper-V: Operations Research-II

3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20
(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit 1:

Unit 2:
Dynamic Programming models - Definition, Bellman's principle of optimality, Minimum path problem. Single additive constraint-Multiplicatively and additively separable return. Single multiplicative constraint, Additively separable return, System involving more than one constraint. Applications in production, Inventory control, Linear programming and reliability. Decision Theory.

Paper VI: Non-Newtonian Fluid Dynamics

3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20
(Internal Assessment will be done by Teacher concerned on the basis of test papers, regularity in the class and performance of the Candidate).

Note: This paper is divided into Two Units. Four questions will be set from each Unit. Candidates are required to attempt FOUR questions in all taking two questions from each Unit. All questions carry equal marks.

Unit 1:

Unit 2:
Unidirectional shear flows. Form of the stress tensor. Steady shear flow material functions. Unidirectional unsteady shear flow material functions. Measurement of viscosity and normal stress coefficients in (i) Cone and plate instrument and (ii) Parallel disk instrument.
Paper-VII: Advanced Graph Theory-II
3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20

(Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate).
Note: This paper is divided into Two Units. Four questions will be set from each Unit.
Candidates are required to attempt FOUR questions in all taking two questions from each
Unit. All questions carry equal marks.

Unit-I:
Vertex cuts and edge cuts, connectivity and edge-connectivity, bonds, blocks, block-
cutpoint graphs, 2-connected graphs, Menger's theorem. Total transformation graphs.
Some properties of total transformation graphs.

Unit-II:
Factors, Tutte's 1-factor theorem, Berge-Tutte formula, Petersen's results on 1-factors and
2-factors. Domination Theory - Domination numbers. Some elementary properties.

Paper-VIII: Relativistic Cosmology and Differential Forms
3 hrs. Duration Theory Paper Max. Marks-80
Internal Assessment Max. Marks-20

(Internal Assessment will be done by Teacher concerned on the basis of test papers,
regularity in the class and performance of the Candidate).
Note: This paper is divided into Two Units. Four questions will be set from each Unit.
Candidates are required to attempt FOUR questions in all taking two questions
from each Unit. All questions carry equal marks.

Unit 1:
Non-static cosmological models, Robertson-Walker model, and its derivation and
Geometrical properties, Friedmann Robertson-Walker model and its scale factor, Three
different forms of scale factor, Doppler effect in Robertson-Walker model, Horizons
(Event and Particle), Big Bang Theory, Steady state theory.

Unit 2:
Brans Dicke theory as an alternative theory of gravitation. Derivation of its field equation
and solution based on Brans Dicke Theory. Differential forms: Exterior differentiation,
Connection 1-form, Ricci Rotation coefficients, Cartan's equation of structure,
Calculation of Riemann Curvature tensor using Differential forms. Curvature 2-form for
Vaidya metric.

Note: 1. There will be Four hour teaching in a week per paper including dissertation
2. For a pass, in M.Phil. course, a candidate shall be required to obtain at least
40% marks in each paper separately in internal assessment and external
assessment and (b) a minimum of 50% marks in aggregate of all the papers
prescribed for the examination (internal and external assessment taken together).