

DEPARTMENT OF APPLIED MATHEMATICS

FACULTY OF ENGG. & TECH.,

M.J.P.R.U., BAREILLY.



Guidelines & Syllabus

of Pre-Ph.D. course work

in

Mathematics

2022-23

Pre-Ph.D. Coursework (Mathematics)

Guidelines

All the admitted candidates shall undertake coursework for a minimum period of one semester as prescribed by the University.

The Coursework shall be treated as Pre-Ph.D. preparation.

The Ph.D. Coursework shall be divided into the following parts :

Part A- Two theory papers

a. **PAPER I – RESEARCH METHODOLOGY**

S. No.	Name of paper	Paper Code	Page No. of detailed syllabus
1.	Research Methodology	RM-711	4

b. **PAPER II – ADVANCED MATHEMATICS** : Students/Scholars can select any one paper among the following 4 papers according to the availability of subject experts/teachers.

S. No.	Name of paper	Paper Code	Page No. of detailed syllabus
1.	Advanced Differential Equations and Fluid Dynamics	RM-712(i)	5
2.	Algebra and Analysis	RM-712(ii)	6
3.	Mathematical Modelling and Optimization Techniques	RM-712(iii)	7
4.	Discrete Mathematics and Wavelet Analysis	RM-712(iv)	8

Part B- REVIEW OF LITERATURE

The candidate shall be required to carry out an executive literature survey of the last 10 years specific to the candidate/supervisor's chosen area. The detailed syllabus can be seen on Page No. 9 .

All candidates admitted to the Ph.D. programme shall be required to complete the Ph.D. Course work successfully prescribed by the Department in the first year. However in case a candidate fails to clear the coursework in the first attempt, he/she shall be given one additional attempt(last) to clear the coursework examination along with the next regular batch to qualify for the examination after paying the requisite fees as decided by the University.

If a candidate fails to pass the coursework examination on the first attempt, he/she would not be given the benefit of the duration of the coursework for the minimum residency period/studentship in continuity. In all such cases, the residency period of only one semester (6 months) shall be reckoned for successful completion of the coursework.

Tabular representation of Ph.D. Coursework is as follows:

Ph.D. Coursework Sections	Paper	Title	Marks			
			External (End Semester Examination)	Internal (Two Mid Tests)		Total
Part A	Paper I	Research Methodology	70	15	15	100
	Paper II	Advanced Mathematics	70	15	15	100
Part B		Review of Literature	50			50

Syllabus

Paper-1 : Research Methodology (RM-711)

Unit-1:- Concept & Method of Research : Meaning of Research, Importance of Research Methodology, Types and approaches, Ethics in research and plagiarism, Quantitative and Qualitative approach, Collection of Information and evaluation, Objectives and Classification, Primary and Secondary sources, Different Resources: Library, Field and Other sources Collection of data from the Library sources.

Unit-2:- Research Writing : Report Writing, The First Draft, Revisions, Language and Style, Use of Quotations, Method of Transcription, Special Elements: Title page, Table of contents, Headings and Sub-headings, Footnotes, Tables and figures, Appendix, Bibliography etc. Elements of Thesis, Typing Instructions, Proof Reading, studying, reviewing and publishing a research paper, knowing funding agencies, writing a research proposal.

Unit-3:- Elementary Computer Science : Fundamentals of Computer including input and output devices, scanner number system(Decimal, Binary, Octal and Hexadecimal), Types of printers, MS-office, E-commerce, Writing Software : LaTeX, HTML, XML etc. Introduction to Python, Data-types in Python, Variables and Operators in Python, Loops functions and structures in Python

Reference Books:-

1. C.R.Kothari : Research Methodology: Methods and Techniques, New Age International Publishers.
2. S.B.Mishra, Shashi Alok : Handbook of Research Methodology, Educreation Publishers.
3. N. K. Denzin, Y. S. Lincon : Handbook of Qualitative Research.
4. M. Depaepe, P. Smeyers : The SAGE handbook of Qualitative Research.
5. D. Maidasani : Learning computer fundamentals, Ms Office and Internet & Web Technology.
6. Anthony Adams : Python Programming for Beginners.

Paper-2(a) : Advanced Differential Equations & Fluid Dynamics (RM-712(i))

Unit-1:-Partial Differential Equations : Classification and properties of second order linear equations, canonical forms, Local existence, Uniqueness and regularity results for 2nd order linear parabolic, elliptic and hyperbolic partial Differential equations, Partial Differential Equations of 2nd order more than one independent variables (Heat, Wave and Laplace Equations), Solutions and their applications.

Unit-2:-Fluid Dynamics : Equations of Continuity in different forms and Equation of Motion, Bernoulli's Pressure Equation, Concept of 2-D Irrotational Motion, Source, Sink and Doublets, Blasius Theorem, Milne's theorem, Motion of a Cylinder, Motion of a sphere, Vortex and Wave Motions.

Unit-3:-Advanced Fluid Dynamics : Newton's law of viscosity. Equations for Newtonian (viscous) fluid. Relation between stress and rate of strain. Navier-stokes equation of motion for a viscous fluid. The energy equation. Equation of state for perfect fluid. Energy dissipation due to viscosity, Its application in Biomechanics (Blood flow in artery, veins, lungs and heart).

Reference Books:-

1. Allen Jeffery – Magnetohydrodynamics (Oliver & Boyd).
2. P. C. Kendell and C. Plumton – Magnetohydrodynamics with hydrodynamics – Vol 1 (Pergamon Press).
3. F. Chorlton – A Text Book of Fluid Dynamics.
4. M. D. Raisinghania & R.S. Agarwal – Advanced Hydrodynamics & Fluid Dynamics.
5. W. A. Strauss – Partial Differential Equations, Wiley publication.

Paper-2(b) : Algebra and Analysis (RM-712(ii))

Unit-1:-Linear Algebra - Linear transformation, rank and nullity, rank–nullity theorem, Dual space and dual basis, Diagonalizable operators. Inner product space, Schwarz’s and Cauchy’s inequalities, Orthogonalisation process, Lie Algebra.

Unit-2:-Real Analysis: Riemann Stieltjes integral, Uniform convergence of series and sequence of functions (Cauchy General Principle of Uniform Convergence, Weirstrass M test, M_n test, Abel test and Driehlet test), Convergence of Improper Integrals (Comparison test, μ test, Abel test and Driehlet test), Measure theory.

Unit-3:-Complex Analysis: Cauchy integral formula and consequences, Taylor and Laurent’s theorems, singularities, residue theorem and its applications, argument principle, Rouché’s theorem, Fundamental theorem of Algebra and its applications, Analytic Continuation, Schwarz Reflection principle, Canonical products, Jensen’s formula, Hadamard’s theorem.

Reference Books:-

1. J.B. Fraleigh :A First course in Abstract Algebra, Narosa Publishing House, New Delhi.
2. L.V. Ahlfors :Modern Algebra, McGraw-Hill, Inc.1996.
3. S.G. Krantz :Complex Analysis: the geometric view points, second edition, Carus math. Monograph. MAA
4. W. Rudin :Principles in Mathematical Analysis(3rd edition), McGraw –Hill,
5. R.V. Churchill :Complex variable and Application, McGraw –Hill.
6. F.B. Hildbrand : Method of Applied Mathematics, PHI, India

Paper-2(c) : Mathematical Modelling and Optimization Technique (RM-712(iii))

Unit-1:-Mathematical Modelling : Need, Characteristics, Classification and limitation of mathematical modeling. Some illustrative examples of modeling through differential equations and Probabilistic Modelling.

Unit-2:-Linear Programming Problem: Integer Programming, Branch and Bound Technique. Applications to Industrial Problems, Optimal Product mix and activity levels. Petroleum refinery operations. Blending problems. Economic Interpretation of dual linear programming problems. Input-Output analysis. Leontief system, Indecomposable and Decomposable Economics.

Unit-3:-Non Linear Programming Problem: Linear inequalities and the theorems of the alternative Kas Theorem. The Optimality criteria of linear programming, Tucker's lemma and existence Theorems of the alternative convex sets-separation theorems. Convex and concave functions, Saddle point optimality criteria without differentiability. The minimization and the local minimization problems and some basic results.

Reference Books:-

1. J.N. Kapur, Mathematical Modelling, New Age International Publisher,1988.
2. R. Aris, Mathematical Modelling Techniques, Dover Publications Inc., New York.
3. G. Hadley, Non-linear and Dynamic Programming, Addison-Wesley, Reading Mass.
4. H. A. Taha, Operations Research, An Introduction. Macmillan Publishing Co. Inc., New York.
5. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research. Sultan Chand & Sons, New Delhi.

Paper-2(d) : Discrete Mathematics & Wavelet Analysis (RM-712(iv))

Unit-1:- Lattice theory & Boolean Algebra – Definition of lattice and its properties, Types of lattices, Direct products, and Homomorphisms. Definition of Boolean Algebra and its properties, The Switching Algebra example. Direct Products and Homomorphisms. Atoms and Minterms. Boolean Forms and their Equivalence. Minimization of Boolean Functions and its applications.

Unit-2:- Fourier Analysis – Motivation and Definition, Fourier Series over the interval of length 2π , complex form of a Fourier series, Convergence of Fourier Series, Riemann Lebesgue Lemma, Convergence at a point and uniform convergence. Motivation and Definition, Basic properties, Fourier Transforms in $L^1(\mathbf{R})$ and $L^2(\mathbf{R})$.

Unit-3:- Wavelet Analysis – Motivation and Definition, Gabor transform, Continuous wavelet transform, Basic properties of Wavelet Transform, Discrete Wavelet Transform. Definition and examples, Construction of Mother Wavelet, Orthonormal spline wavelets, Construction of compactly supported Wavelets, Mallat's algorithm.

References

1. S. B. Singh, J. Kishore and Ekata, Discrete Structures, Khanna Book Publishing Company.
2. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
3. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
4. K. Ahmad and F.A.Shah: Introduction to wavelets with Applications, Real World Education Publishers, New Delhi (2013).
5. E. Hernandez and G. Weiss: A First Course on Wavelets, CRC press, New York, (1996).

PAPER-3: Review of Literature (Mathematics)

Identification of problem and its solutions:

Students have to develop annotated bibliography on and around the theme of research which must cover at least 10 books OR reviewing of at least 20 research papers in the relevant field, published in reputed SCI/Scopus/UGC/refereed Journals.