BERHAMPUR UNIVERSITY

Syllabus
For
M.Phil/Pre-Ph.D. in Mathematics

P.G. DEPARTMENT OF MATHEMATICS
Berhampur University,
Bhanja Bihar, Berhampur :-760007,Ganjam, Odisha

2023-24

Syllabus for M.Phil/Pre-Ph.D. Mathematics 2023-24

Objective of the Course: The M.Phil/Pre Ph.D is offered by the P.G. Department of Mathematics as a full time course and its main aim is to give opportunity to students to acquire knowledge or develop skills and expertise relevant to their research interest.

Detailed Course Structure

Semester	Name of the Paper Code	Name of the Paper	No. of Credits	Marks 100	Remarks End Sem: 80 Marks + Mid Sem : 20
Semester-I	MATH MPC1	RESEARCH METHODOLOGY AND COMPUTATIONAL MATHEMATICS	04	100	-Do-
	MATH MPC2	BOUNDED AND UNBOUNDED OPERATORS	04	100	-Do-
	MATH MPS3	PRESENTATION OF A REVIEW REPORT (BASED ON 03 IMPORTANT PUBLISHED RESEARCH ARTICLES OF REPUTED JOURNALS)	02	50	
		PUBLICATION AND RESEARCH ETHICS	02	50	
	Any one from the following Elective				
	MATH MPE1	MATRIX TRANSFORMATIONS IN SEQUENCE SPACES	04	100	-Do-
	MATH MPE2	FUNCTIONAL DIFFERENTIAL EQUATIONS	04	100	-Do-
	MATH MPE3	RELATIVITY AND COSMOLOGY	04	100	-Do-
	MATH MPE4	INVENTORY AND PRODUCTION MANAGEMENT	04	100	-Do-
	MATH MPE5	NONLINEAR FUNCTIONAL ANALYSIS	04	100	-Do-
	MATH MPE6	ANALYTIC NUMBER THEORY	04	100	-Do-
	MATH MPE7	CLASSICAL BANACH SPACES	04	100	-Do-
	MATH MPE8	LINEAR PROBLEMS AND CONVEXITY, TECHNIQUES IN GEOMETRIC THEORY	04	100	-Do-
	MATH MPE9	MATHEMATICAL PROGRAMMING	04	100	-Do-
Semester-II	MATH MPS 4	REVIEW OF FOUR RESEARCH PROGRESS PRESENTATION (THROUGH) PPT	04	100	
	MATH MPD1	DISSERTATION	12	300	

Total Credit : 32

MPC – Core Course 300 (Mandatory with no choice)

MPE- Elective 100 (Mandatory with choice departmentally)

PRO- Project 100

DISSERTATION- 300

Note: Pre Ph.D students have to register for 16 credits of 400 marks to appear only Semester I, while M.Phil students have to register for 32 credits of 800 marks to appear both Semester –I & II.

DETAILED SYLLABUS

SEMESTER-I

Sub. Code: MATH MPC1	**RESEARCH METHODOLOGY AND COMPUTATIONAL MATHEMATICS**	
Semester: I	**Credit: 4**	**Core Course**
Pre-requisites: Basic knowledge in Mathematics		
Course Outcome: ➢ Students able to write research paper. ➢ To solve any kind of mathematical equations by applying mathematical models.		

Unit-I 10 hours

The Basics, Topics Specific to the Writing of Mathematics, Exposition, Other types of Writing.

Unit-II 10 hours

Computational Models, Basic of Algorithm, Divide and Conquer

Unit-III 10 hours

Greedy Method, Dynamic Programming.

Unit-IV 10 hours

Further Divide and Conquer.

BOOKS PRESCRIBED:

1. Primer of Mathematical writing- Stven G. Krantz (Universities Press) Chapters 1, 2, 3, 4 .

2. Design Method and analysis of algorithms-S.K. Basu (Prentice Hall of India) Chapters: 0, 1, 2, 3, 4, 5.

Sub. Code: MATH MPC2	BOUNDED AND UNBOUNDED OPERATORS	
Semester: I	Credit: 4	Core Course
Pre-requisites: Basic knowledge in Functional Analysis and Linear Algebra		
Course Outcome: ➢ Students will be able to understand the research on operator theory.		

Unit-I 10 hours

Test function and Distributions, Fourier Transforms.

Unit-II 10 hours

Banach Algebras.

Unit-III 10 hours

Commutative Banach Algebras, Tauberian Theory.

Unit-IV 10 hours

Bounded operators on Hilbert Space, Unbounded operators.

BOOKS PRESCRIBED:

Functional Analysis-W. Rudin (Tata McGraw-Hill) Chapters : 6,7,8,9,10,11,12,13.

Sub. Code: MATH MPS3	SEMINAR PRESENTATION & RESEARCH ETHICS	
Semester: I	Credit: 4	
Pre-requisites: Basic knowledge in Computers		
Course Outcome: ➢ To create awareness about publication ethics, publication misconducts, predatory publications, Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools.		

Unit-I

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP),Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and

misrepresentation of data, Publication ethics: definition, introduction and importance, Best practices / standards setting initiatives and guidelines: COPE, WAME, etc, Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals Predatory publishers and joumals

Unit-II

Open access publications and initiatives, SHERP AlRoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Use of plagiarism software like Turnitin, Urkund and other open source software tools, Indexing database, Citation databases: Web of Science, Scopus, etc. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite, Score Metrics: h-index, g index, il0 index, altmetrics.

Unit-III

Review of Literature Preparation

Unit-IV

Presentation in a seminar (review report based on review of 3(three) Important Research Papers published in reputed Journal)

REFERENCE BOOKS

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN: 978- 9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
5. Resnik, D. B. (2011). What is ethics in research & why is it important. National 6 Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resourcesibioethics/whatis/index.cfm Beall.J, (2012).
6. Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.orgil0.l038/489179a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Govemance(2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.inlpdf/Ethics Book.pdf

Sub. Code: MATH MPE1	MATRIX TRANSFORMATIONS IN SEQUENCE SPACES	
Semester: I	Credit: 4	Elective Course
Pre-requisites: Basic knowledge in Sequence Spaces		
Course Outcome: ➢ Students will be able to pursue the research on sequence spaces.		

Unit-I 10 hours

Generalised Korhe-Toeplitz Duals. Operator Norlund means.

Unit-II 10 hours

Characterizations of Matrix Classes.

Unit-III 10 hours

Tauberian Theorems,Consistency Theorems.

Unit-IV 10 hours

Mappings between sequence spaces. Topological properties of CA, the Extent of CA, The Bounded Consistency Theorem.

BOOKS PRESCRIBED

1. Infinite Matrices of Operators-I.J. Maddox(Springer-Verlag)Chapters :3, 4, 5,6,7.
2. Sequence Spaces : W.H. Ruckle (Pitman) Chapters : 4,5 (Sections 4,5,6, only)

Sub. Code: MATH MPE2	FUNCTIONAL DIFFERENTIAL EQUATIONS	
Semester: I	Credit: 4	Elective Course
Pre-requisites: Basic knowledge in differential equations		
Course Outcome: ➢ Students will carry on the research on higher order non homogenous delay differential equations.		

Unit-I 10 hours

Uniqueness and Lipchitz conditions for ordinary differential equations, the linear equations of orders.

Unit-II 10 hours

Linear ordinary differential systems, Introduction to delay differential equations.

Unit-III 10 hours

Introduction to delay differential equation, existence theory, Linear delay-differential systems.

Unit-IV 10 hours

Stability.

BOOKS PRESCRIBED

Ordinary and Delay differential Equations: R. D. Driver (Springer-Verlag) Chapters: 2,3,4,5,6,7,8.

Sub. Code: MATH MPE3	**RELATIVITY AND COSMOLOGY**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in fluid dynamics and quantum mechanics		
Course Outcome: ➢ Students will be able to write research paper on field equations.		

Unit-I 10 hours

Space-time continuum, the three plus one dimensions of space-time , the geometry corresponding to space-time, the signature of the line element and three kinds of interval, Lorentz rotation of axes, transformation to proper coordinates.

Unit-II 10 hours

Riemann Christoffel Tensor , Covariant curvature tensor and its properties, Ricci Tensor, Curvature invariant, Einstein space, Bianchi's identity, Riemannian Curvature, Einstein space, Flat space, space of constant curvature, for Schur's theorem.

Unit-III 10 hours

The fundamental principles of General Relativity, Principle of Covariance, Principle of equivalence, Principle of Mach, Gravitational field in empty space, Gravitational field in

the presence of matter and energy, Simple consequences of principle of equivalence, Newton's theory as a first approximation, The Schwarzschild line element, the three crucial tests of Relativity.

Unit-IV 10 hours

Line elements for systems with spherical symmetry, static line element with spherical symmetry, Schwarzschild exterior and interior solutions, Non-static line elements with spherical symmetry-Birkoff's theorem, The generalized Lorentz electron theory the field equations, the gravitational field of a charged particle.

BOOK PRESCRIBED:

1. Relativity, Thermodynamics and Cosmology, R.C. Tolman ,Clarendon press, Oxford. Chapter II(Art 13-18), VI(72-75,77-83), VII(94-99,102 ,107)
2. Tensor Calculus by Bary Spain, Radha publishing House, Calcutta Chapter V

Sub. Code: MATH MPE4	**INVENTORY AND PRODUCTION MANAGEMENT**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in Operation Research		
Course Outcome: ➢ To solve any kind of inventory models of deteriorating items by applying different mathematical methods.		

Unit-I 10 hours

Deterministic Inventory Lot-Size Model with Time proportional demand. Deterministic joint replenishment policy. Inventory Control of deteriorating items (discrete and continuous).

Unit-II 10 hours

Inventory Control under Inflationary Conditions. Inventory models with Stock dependent demand. Interaction of Inventory and trade credit policies. Impact of marketing policies on Inventory Decisions. Joint buyer-seller Inventory model.

Unit-III 10 hours

The Distribution frees newsboy problem and its extensions. Introduction to VMI and supply Chain. Interaction of Inventory, Queues and Reliability.

Unit-IV 10 hours

Aggregate production Planning: Fixed and Variable Work Force Model Inventory Location Model production planning with Time Varying Demand.

REFERNCE BOOKS :

1. Walters, C.D.J., 2003 Inventory Control & Management, John Wiley & Sons.
2. Heizer, J and Render, B, 2001, Princilples of operations Management, Prentice Hall.
3. Zipkin, P.H. 2000, Foundatilons of Inventory Management, Mc Graw-Hill/Irwin.
4. NJ Bernard, P. 1999, Integrated inventory Management, John Wiley and Sons, New York.
5. Silver, E, Pyke, D. and Peterson, R, 1998. Inventory Management and production planning and Scheduling, John Wiley and Sons, New York.
6. Tony Wild, 1998, Best Practilce lin Inventory Management, John Wiley & Sons.
7. Bedworth and Bailey, 1987, Integrated Production Control System, John Wiley & Sons. New York
8. Plossl, G, 1985, Production and Inventory Control : Principles and Techniques. Prentice Hall,Englewood Cliffs,NJ.
9. Relevant research papers.

Sub. Code: MATH MPE5	**NONLINEAR FUNCTIONAL ANALYSIS**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in Functional Analysis		
Course Outcome: ➢ Students will be able to write research paper on operators on Banach Spaces.		

Unit-I 10 hours

Preliminaries Calculus in Banach Spaces.

Unit-II 10 hours

Monotone Operators.

Unit-III 10 hours

Fixed point theorems Banach's Contraction Principle and its generalizations. Nonexpansive Mapping fixed point theorems of Brouwer and Schaudes.

Unit-IV 10 hours

Fixed point theorems for multifunctions. Common fixed point theorems Degree theory and Condensing Operators.

BOOKS PRESCRIBED

Some topics in nonlinear functional Analysis by Joshi and Bose (Wiley-Eastern).
Chapters : 1, 2, 3, 4(omit sections 4, 6, 4, 7), 5.

Sub. Code: MATH MPE6	**ANALYTIC NUMBER THEORY**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in number theory		
Course Outcome: ➢ Students will carry on research on number theory.		

Unit-I 10 hours

Distribution of Prime Numbers, Congruence's.

Unit-II 10 hours

Finite Abelian groups and their characters, Direchlet's theorems on primes in A.P.

Unit-III 10 hours

Quadratic Residues and Quadratic Reciprocity Law, Dirichlet's series and Euler Products.

Unit-IV 10 hours

The functions g (s) and L (s,y,) Analytic proof of the prime Number theorem.

BOOKS PRESCRIBED

An Introduction to Analytic Number Theory- T.M. Apostol (Narosa)
Chapters: 4, 5, 6, 7, 9, 11, 12, 13.

Sub. Code: MATH MPE7	**CLASSICAL BANACH SPACES**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in Functional Analysis		
Course Outcome:		

- To solve any kind of research problems on functions spaces.

Unit-I 10 hours

Schauder Bases.

Unit-II 10 hours

The Spaces co and lp.

Unit-III 10 hours

Symmetric Bases.

Unit-IV 10 hours

Orlicz Sequence Spaces.

BOOKS PRESCRIBED

Classical Banach Spaces-Lilnderstraws and Tzafriltil (Springer)
Chapters : 1, 2, 3, 4.

Sub. Code: MATH MPE8	**LINEAR PROBLEMS AND CONVEXITY, TECHNIQUES IN GEOMETRIC THEORY**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in Complex Analysis		
Course Outcome: - Students will be able to find extreme points and closed convex hulls of several classes of univalent analytic functions.		

Unit-I 10 hours

Elementary properties of univalent functions, special families of univalent functions, Subordination and the Herglatz formula.

Unit-II 10 hours

The linear topological structure of the set of the analytic functions, Extreme points and closed convex hulls of several classes.

Unit-III 10 hours

Applications to external problems. Supports point of several classes.

Unit-IV 10 hours

Subordination, external point theory and Hp-spaces variability regions for families of analytic functions.

PRESCRIBED BOOKS

Linear problems and convexity techniques in geometric functions theory by D.J. Hallenbanck and T.H. Mec Gregor., Pitman.
Advanced Publishing Programme : Buston London, Melbourne 1984.

REFERENCE BOOKS:

1. Univalent Functions by P.L. Duren, Springer-Verlag New York (1983)
2. Geometric theory of functions of a complex variable by G.M. Goluzin, Translation of Mathematical Monographa, Vol, 26 Ame : Math, Soc. 1969.
3. Univalent Functions, Vol.I,II,III, by A.W. Goodman, Maviner Publishing Company. Tampa (1988)
4. Linear Operators : I Generalo Theory, Pure and Applied Mathematics. Vol.7 (1958) by N. Dunford and J.T. Schwariz.
5. Multivalent functional by W. K. Hayman Cambridge University Press, Cambridge(1958).

Sub. Code: MATH MPE9	**MATHEMATICAL PROGRAMMING**	
Semester: I	**Credit: 4**	**Elective Course**
Pre-requisites: Basic knowledge in Operation Research		
Course Outcome: ➢ Students will be able to design a mathematical model and solve the problems by using different mathematical methods.		

Unit-I 10 hours

Generalized Convexity : Invexity and its generalization. F. Convex Functions and their generalization, B-Vex and Related Functions with applications to multi-objective fractional and minimax programming. Sub-gradient land Sub-Differential of Convex Function Sub-gradient Duality Necessary and Sufficient Optimality Conditions for MONLPP in term of Sub-gradients.

Unit-II 10 hours

Complementarity Problem : Liner Complementarity problem, Equivalence of LPP and I.C.P. Equivalence of OPP and LCP, Equivalence of LCP and problem of finding equilibrium points of Bimatrix game.
Non-Linear Complementarity, Generalized LCP and its equivalence to Multi objective Programming Problem.

Unit-III 10 hours

Goal Programming : Formulation of Goal Programming Models, Methods of Solution for Goal and Multi-Objective programming Goal Programming with Linear Fractional Objective Function.

Unit-IV 10 hours

Fuzzy Programming : Concept of Fuzziness in Objective Function or Constraint Functions or Both in LPP and NLPP. Interior Point Methods for Solving Linear Programming Problem.

PRESCRIBED BOOKS

1. Clarke, F.H, Ledyaev yu. S. Stern. R.J. Wolenski P.R, "Non-Smooth Analysis and Control Theory",Springer.
2. Cottle R.W., Pang J.S. and Stone RE (1992) "Linear Complementarity", Academic Press N.Y.
3. Ignizio, J.P,"Linear Programming in Single and Multiobjective System", Prentice-Hall, Englewood Cliffs, N.Y.
4. Ignizio,J.P.,"Goal Programming A Tool for Multiobjective Analysis", Vol.29,No-2,1109-1119(1978).
5. Zeleny, M. "Linear Multiple Objective programming", Lecture Notes iln Economics and Math, Systems, Springer, Berlin.
6. Murty, Linear programming-'Interior Point Methods'.

SEMESTER-II

Sub. Code: MATH MPS4	**REVIEW OF RESEARCH PROGRESS (THROUGH) PPT**	
Semester: II	**Credit: 4**	
Pre-requisites:		
Course Outcome: ➢ Students will be able to write a research paper.		

Unit-I

Presentation on Research proposal (overall).

Unit-II

Presentation on review of literature on the Dissertation topic.

Unit-III

Presentation on methodology and plan of research finding.

Unit-IV

Presentation of final dissertation or Pre-submission of dissertation.

NB: Four presentations based on the dissertation carrying 01 credit per presentation to be presented every month during the period of writing the dissertation.

EVALUATION: The candidate has to present his/her work before the Dept. RAC periodically and submit a report at the end of each presentation. The Dept. RAC will evaluate each report and send the overall grade secured by the candidate along with the Dissertation to the Controller of Examination at the end of the 2nd semester.

PAPER- MATH MPD1

Dissertation : 12 Credits