



# **BERHAMPUR UNIVERSITY**

## **COURSE OF STUDIES**

**FOR  
THE M.PHIL./PRE-DOCTORAL IN MATHEMATICS EXAMINATION**

**2017**

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## M.Phil./Pre-Ph.D. Course of studies

**The course work is a prerequisite for M.Phil./Pre-Ph.D. Programme. The course work consists of two semesters of 32 credit points**

### **Semester-I (16 Credits)**

The first semester consists of four papers of four credits. There shall be three theory papers and each paper shall be 4 (four) credits of four hour duration. Each question paper should contain 8 questions covering uniformly in the syllabus. The examinees are required to answer 4 questions.

<b>CC-1</b> :	Research Methodology and Computational Mathematics	4 Credits
<b>CC-2</b> :	Bounded and unbounded operators	4 Credits
<b>CC-3</b> :	Seminar presentation	4 Credits
<b>CE-1</b> :	One elective course related to research to be chosen from the followings: i) Matrix Transformation in sequence spaces. ii) Functional Differential Equations. iii) Relativity and Cosmology. iv) Inventory and production management. v) Non-linear Functional Analysis. vi) Fluid Dynamics. vii) Analytic Number Theory. viii) Classical Banach Spaces. ix) Linear problems and Convexity techniques in geometric function theory. x) Mathematical programming.	4 Credits

### **Semester-II (16 Credits)**

<b>CC-4</b> :	Review of research progress (through) PPT	4 Credits
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Four presentations based on the dissertation carrying 01 credit per presentation to be presented every month during the period of writing the dissertation.

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.

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 2<sup>nd</sup> semester.

**Dissertation : 12 Credits.**

**DETAILED SYLLABUS**

**SEMESTER-I**

**PAPER-CC-I**

(4 Credits)

**RESEARCH METHODOLOGY AND COMPUTATIONAL MATHEMATICS**

- a. Essays on Mathematical Writing 1 Credit  
Unit-1: The Basics, Topics Specific to the Writing of Mathematics, Exposition, Other types of Writing.

**BOOKS PRESCRIBED:**

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

- b. Computational Mathematics 3 Credits

Unit-2: Computational Models, Basic of Algorithm, Divide and Conquer

Unit-3: Greedy Method, Dynamic Programming.

Unit4: Further Divide and Conquer.

**BOOKS PRESCRIBED:**

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

**PAPER-CC-II**

(4 Credits)

**BOUNDED AND UNBOUNDED OPERATORS**

Unit-1 : Test function and Distributions, Fourier Transforms.

Unit-2 : Banach Algebras.

Unit-3 : Commutative Banach Algebras, Tauberian Theory.

Unit-4 : 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.

**PAPER – CC-III**

(4 Credits)

**Seminar Presentation**

Presentation with a review report based on review of 5(five) Important Research Papers published in reputed Journal.

**PAPER-CE-I**

(4 Credits)

**(Any one from the following)**

**a) MATRIX TRANSFORMATIONS IN SEQUENCE SPACES**

Unit-1 : Generalised Korhe-toeplitz Duals. Operator Norlund means.

Unit-2 : Characterizations of Matrix Classes.

Unit-3 : Tauberian Theorems,Consistency Theorems.

Unit-4 : 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)

### **b) FUNCTIONAL DIFFERENTIAL EQUATIONS**

Unit-1 -Uniqueness and Lipchitz conditions for ordinary differential equations, the linear equations of orders.

Sections : 4,5,6,8,10,11,12 and 13.

Unit-II--Linear ordinary differential systems, Introduction to delay differential equations.

Section : 14,15,16,17,18,20,21,22 .

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

Sections : 23,24,25,26,27,28,29.

Unit-IV : Stability.

Sections : 30,31,32,33,34.

## **BOOKS PRESCRIBED**

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

### **c) RELATIVITY AND COSMOLOGY**

#### Unit-I

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

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

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

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

**d) INVENTORY AND PRODUCTION MANAGEMENT**

Deterministic Inventory Lot-Size Model with Time proportional demand. Deterministic joint replenishment policy. Inventory Control of deteriorating items (discrete and continuous). 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. The Distribution free newsboy problem and its extensions.

Introduction to VMI and supply Chain.

Interaction of Inventory, Queues and Reliability.

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

Suggested Books :

1. Walters, C.D.J., 2003 Inventory Control & Management, John Wiley & Sons.
2. Heizer, J and Render, B, 2001, Principles of operations Management, Prentice Hall.
3. Zipkin, P.H. 2000, Foundations 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.

### **e) NONLINEAR FUNCTIONAL ANALYSIS**

Unit-I Preliminaries Calculus in Banach Spaces.

Unit-II Monotone Operators.

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

Unit- IV 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

### **f) FLUID DYNAMICS**

Unit-I: Derivation of the equation of motion in a compressible viscous fluid(Navier-Stokes equations, General properties of the Navier-Stokes equations.

Unit-II: Exact solutions of the Navier stockes equations.

Unit-III: Boundary-layer equations for two-dimensional flow; boundary layer on a plate.

Unit-IV: Exact solutions of the steady-state boundary-layer equations in two-dimensional motion. Approximate methods for the solution of the two-dimensional, steady boundary layer equations.

#### **BOOKS PRESCRIBED**

Boundary Layer Theory(6<sup>th</sup> Edition) – Hermann Schliting(Mc.Graw-Hill).

Chapters : III (a. g.) IV (a,c,d,e) V,VII,IX (a,b,c,), X (a,b).

### **g) ANALYTIC NUMBER THEORY**

Unit-I : Distribution of Prime Numbers, Congruence's.

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

Unit-III : Quadratic Residues and Quadratic Reciprocity Law, Dirichlet's series and Euler Products.

Unit-IV : 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

### **h) CLASSICAL BANACH SPACES :**

Unit-I : Schauder Bases  
Unit-II : The Spaces  $c_0$  and  $l_p$ .  
Unit-III : Symmetric Bases.  
Unit-IV : Orlicz Sequence Spaces.

## **BOOKS PRESCRIBED**

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

### **i) LINEAR PROBLEMS AND CONVEXITY, TECHNIQUES IN GEOMETRIC THEORY**

Unit-I: Elementary properties of univalent functions, special families of univalent functions, Subordination and the Herglitz formula.  
Unit- II: The linear topological structure of the set of the analytic functions, Extreme points and closed convex hulls of several classes.  
Unit-III: Applications to external problems. Supports point of several classes.  
Unit- IV: Subordination, external point theory and  $H_p$ -spaces variability regions for families of analytic functions.

## **BOOKS PRESCRIBED**

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.

## **BOOKS FOR REFERENCE**

- 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. Schwarziz.

- 5) Multivalent functions by W. K. Hayman Cambridge University Press, Cambridge(1958).

### **j) MATHEMATICAL PROGRAMMING**

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 and Sub-Differential of Convex Function Sub-gradient Duality Necessary and Sufficient Optimality Conditions for MONLPP in term of Sub-gradients.

Complementarity Problem : \_ Linear 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 Multiobjective Programming Problem.

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

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.

#### **BOOKS PRESCRIBED**

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 in Economics and Math, Systems, Springer, Berlin.
6. Murty, Linear programming-Interior Point Methods'.



**SEMESTER-II**  
**PAPER-CC-4**  
**REVIEW OF RESEARCH PROGRESS (THROUGH) PPT** 4 credits

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

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