OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/130th AC/Syllabus-Course Work-Math./2024/1097 Date: 09.05.2024

NOTIFICATION

As recommended by the meeting of the Board of Studies (BoS) in Mathematics held on 09.02.2024 and 154th Meeting of the Post Graduate Board, Dibrugarh University held on 03.04.2024, the 130th Meeting of the Academic Council, Dibrugarh University held on 09.04.2024 vide ***Resolution No. 11*** has approved the syllabus of the Ph.D. Course Work in Mathematics Programme with immediate effect.

The syllabus is attached herewith.

Issued with due approval.

09/05/2024

Deputy Registrar (Academic)
Dibrugarh University

Copy for kind information and necessary action to:

1. The Hon'ble Vice-Chancellor, Dibrugarh University.
2. The Deans, Dibrugarh University.
3. The Registrar, Dibrugarh University.
4. The Head, Department of Mathematics, Dibrugarh University.
5. The Controller of Examinations i/c, Dibrugarh University.
6. The Joint / Deputy Controller of Examinations – 'B', 'C' & 'A', Dibrugarh University.
7. The Programmer, Dibrugarh University with a request to upload the notification in the Dibrugarh University Website.
8. File.

09/05/2024

Deputy Registrar (Academic)
Dibrugarh University

ANNEXURE – I

(Detail Syllabus of the Ph.D. Pre-Registration Course Work in Mathematics to be effective from the Session 2024)

(Recommended by B.O.S. in Mathematics, D.U. in its meetings held on 09.02.2024 and approved by the Academic Council meeting held on……. and effective from the session……..)

Syllabus for Six-Month Pre-registration Course Work of Ph. D. Programmmes in Mathematics

(w.e.f. 09/02/2024)

(Forwarded by the DRC in Mathematics held on 08/12/2023)

COURSE STRUCTURE & EXAMINATION PATTERN OF THE Ph.D. PROGRAMME IN MATHEMATICS

1. There shall be four Courses in One-Semester Course work for the Ph.D. programmes conducted in Dibrugarh University comprising with the following components:

   Course - I : Research Methodology (core)
   Course - II : Optional (Intra/ Inter-Departmental)
   Course - III : Optional (to be offered by the prospective Supervisor concerned).
   Course - IV : Assignment (under guidance of the prospective Supervisor concerned)

   Provided that, the total credit of the Ph.D. Pre-Registration Course Work should be within the range of 16-20 Credit.

2. The syllabi for the Ph.D. Course Work shall be prepared by the DRC and through the School Board concerned and shall come into effect after approval of the Post Graduate Board, Dibrugarh University.

3. The distribution of marks of the Course Work shall be as follows:

Courses	Internal Assessment	End Semester examination	Total Weightage
Course I	40%	60%	100%
Course II	40%	60%	100%
Course III	40%	60%	100%
Course IV	80%(assignment writing)	20%(viva on the assignment)	100%
Total Credit (16-20)			

4. Candidates shall have to secure a minimum of 45% marks in aggregate to pass a paper individually.

5. The mode of Internal Assessment (IA) shall be decided and implemented by the Department/ Centre concerned. The mode of IA shall have to be communicated to the Controller of Examinations, Dibrugarh University at the time of submission of IA marks.

6. Examination & Declaration of Results:

   (a) The IA of a student shall be conducted by the course teacher of the student concerned. The marks of the IA shall be submitted to the Controller of Examinations, Dibrugarh University by the Head of the Department/ Director of the Centre concerned.

   (b) The End semester examination shall be conducted by the Controller of Examination, Dibrugarh University in consultation with the Head of the Department/ Director of the Centre concerned.

   (c) The result shall be declared by the Controller of examinations.

(d) The examinations shall be conducted as per the existing examination ordinance of the University.

7. The result of the candidates appeared in the examination for Ph.D. Course Work shall be awarded in the following Grade system:

Letter Grade with meaning		Grade Point
O	Outstanding	10 (Marks securing above 95%)
A+	Excellent	9 (Marks securing 90%-95%)
A	Very Good	8 (Marks securing 80%-90%)
B+	Good	7 (Marks securing 70%-80%)
B	Above Average	6 (Marks securing 60%-70%)
C	Average	5 (Marks securing 50%-60%)
P	Pass	4 (Marks securing 45%-50%)
F	Fail	0 (Marks securing below 45%)
Ab	Absent	0

A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

8. Every candidate shall be given a maximum of two consecutive chances (including the first regular chance) for passing the examination. Not appearing in an examination after becoming eligible to appear in the same amounts to losing a chance.

9. The candidates who have failed the examination in the first chance shall have to clear the same in the second and last chance; which shall be held within three months from the date of declaration of results.

A candidate shall have to appear in the second chance only in the failed paper(s) to pass the examination.

10. The candidates passed in the Ph.D. Pre-registration Course Work with not below the Letter Grade **B** shall be eligible to go for Ph.D. registration.

11. Matters not covered by the above Regulations shall be decided as per the other statutory provisions of the University.

DETAIL SYLLABUS OF THE Ph.D PRE-REGISTRATION COURSE WORK IN MATHEMATICS

COURSE I : RESEARCH METHODOLOGY (Core)

COURSE II : OPTIONAL (Any one of the following)

1. Group A : Fundamentals of Game Theory
2. Group B : Linear Algebra and Real Analysis
3. Group C : Scientific and Engineering Computations

COURSE III : OPTIONAL

(Any one of the following, to be offered by the prospective Supervisor concerned)

1. Group A : Advanced Fluid Dynamics with Magnetohydrodynamics
2. Group B : Cooperative Games and its Applications to Networks
3 Group C : Fuzzy Sets and Fyzzy Logic
4. Group D : Mathematical Theory of Evidence
6. Group E : Theoretical Plasma Dynamics
7. Group F : Traffic Thoery and Graph Measures
8. Group G : Introduction to Mathematical Biology
9. Group H : Advanced Functional Analysis

COURSE IV : ASSIGNMENT

(Under guidance of the prospective Supervisor concerned)

Course-I

Research Methodology Marks: 60

Section A : Basic Aspects Marks: 30

Unit 1 : Fundamentals of Mathematical Research Marks: 10

Basic issues of Mathematics, objects and avenues of Mathematical research methodology of Mathematical research, various methods adopted for doing research in Mathematics.

Unit 2 : Mathematics Research Preparation Marks: 20

How to organize a paper, How to write a mathematical statement viz. theorem, remark, proof etc. how to write Abstract and Bibliography, Review of Literature, Preparation of a talk and seminar paper, Preparation of a synopsis/ project.

Section B : Computer Application Marks: 30

Unit 1 : **Manuscript Preparation using Latex**: Marks: 15

Use of Latex, Preparation of a manuscript using Latex (Research Paper and Seminar presentation)

Unit 2 : Use of Mathematical Software: Marks: 15

Mathematica, Matlab, Maple for obtaining solutions for various Mathematical problems.

Textbooks:

1. ***A Primer of Mathematical Writings, S. G. Krantz, University Press.***
2. ***Handbook of writing of Mathematical Sciences, SIAM, Philadelphia, Pensylvenia, 1993.***

Reference Books*:*

1. E-resource: Methmath research.htm (To be supplied by the Department)

2. A primer to Latex Tutorials, Ed. E. Krishnan, Indian Tex users group,Trivandrum, India, 2003 September, E-source: http://www.tug.org.in/tutorials.html

Course II

Group (A): Fundamentals of Game Theory Marks: 60

Unit 1 : Basics of Game Theory Marks 12

Historical background; Zero sum games; non-zero sum games; extensive form games; Cooperative games; Bargaining games; Cooperative versus non-cooperative games;

Unit 2 : Finite Two person Zero sum games Marks 12

Saddle point; Minimax and maximin strategies; Solving 2 x n and m x 2 games; Dominance; Mixed strategy; Linear Programming Methods to solve a two person zero sum game.

Unit 3: Finite Two Person non-zero sum games Marks 12

Basic Definitions; Nash equilibrium; Pure and mixed strategies in Nash equilibrium.

Unit 4 : Finite Extensive Form Games Marks 12

The Extensive Form; The Strategic Form; Backward induction and subgame perfection; Perfect Bayesian equilibrium.

Unit 5 : Cooperative Game Theory Models Marks 12

Cooperative Games with Transferable Utility; The Core; The Shapley value; The Nucleolus.

Textbook:

"Hans Peter, Game Theory - A Multi level Approach, Springer, 2008."

Reference book:

"R.P Gilles, The Cooperative Game Theory of Networks and Hierarchies, Springer 2008".

Course –II

Group (B): Linear Algebra and Real Analysis Marks: 60

Unit 1 : Linear Algebra Marks: 30

Vector spaces: subspaces, sums and direct sums; finite dimensional vector spaces: bases and dimensions; Linear maps: null-spaces and range, invertibility; polynomials with real and complex co-efficients; Eigenvalues and eigen vectors: triangularization and diagonalization of operators on finite dimensional vector spaces; Inner- product spaces: orthonormal bases, linear functional and adjoins; Operators on inner-product spaces: self-adjoint and normal operators, minimal polynomial, Jordan form; Traces and determinants of operators and matrices.

Unit 2 : Real Analysis Marks: 30

Completeness properties of real numbers, countable and uncountable sets, cardinality. Norms and metrics: Metric spaces, convergence of sequences, completeness, connectedness and sequential compactness; Continuity and uniform continuity; sequences and series of functions, uniform convergence, equicontinuity, Ascoli's theorem, Weierstrass approximation theorem, power series. Calculus of functions of several real variables: Partial and directional derivatives, differentiability, Chain Rule, Taylor's theorem, Maxima and Minima, Lagrange multipliers, Inverse function theorem, Implicit function theorem.

Textbooks:

1. ***Seymour Lipschutz, Linear Algebra, Schaum's Series, Tata McGraw Hill Edition, 2004***
2. ***Tom M. Apostal, Methematical Analysis, Narasa Publishing House, 1997.***

Reference books:

1. ***K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996***
2. ***W. Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw Hill, 1976.***

Course-II

Group (C): Scientific and Engineering Computations Marks: 60

Unit 1: Approximating Eigenvalues Marks: 20

Characteristic value problem, The Power method, The QR method, The Householder's method, Application of Eigen values

Unit 2: Numerical Solutions to Partial Differential Equations Marks: 20

Elliptic partial differential equations, Parabolic partial differential equations, Hyperbolic partial differential equations.

Unit 3: Finite Element Method Marks: 20

Weighted Residual methods, Variational methods, Finite elements, Finite element method (Basic concept)

Textbooks:

1. ***Numerical Analysis by Richard L. Burden and J. Douglas Faires, Brooks/ Cole Publishing Company (Chapter- 12).***
2. ***Numerical Analysis for Scientists and Engineers:Theory and C programs by Madhumangal Pal,Alpha Science International,2007.***

Reference Books:

1. ***Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Addison- Wesley. (Chapter – 6)***
2. ***Numerical Solution of Differential Equations by M. K. Jain, Wiley Eastern Limited (Chapter – 8).***
3. ***Numerical methods for Scientists and Engineers by H. M. Antia, Hindustan Book Agency, New Delhi***
4. ***Computational Methods for Partial Differential Equations, by M. K. Jain, S. R. K. Iynger and R. K. Jain, Wiley Eastern Limited***
5. ***Finite Element Procedures by Klaus- Jurgen Bathe, Prentice Hall of India Pvt.Limited***.

Course: III

Group A: Advanced Fluid Dynamics with Magnetohydrodynamics Marks: 60

Unit-1: Dimensional Analysis Marks: 15

Similitude; Geometrical, Kinematic and Dynamic Similarity; Dimensionless numbers, Techniques of Dimensional Analysis; Rayleigh technique and Buckingham pi-theorem.

Unit-2: Heat and Mass Transfer Marks: 25

Heat Transfer, the energy equation-conservation of energy, temperature distribution in (i) Couette flow, (ii) Poiseuille flow, (iii) Hagen-Poiseuille flow; Thermal boundary layer, thermal boundary layer equation in two dimensional flow, free convection and forced convection.

Unit-3: Basic of MHD: Marks: 20

Basics of MHD, Basic Laws of electromagnetism, Lorentz force, Maxwell Stress, Hartmann flows.

Textbooks:

1. Boundary Layer theory by H. Schlichting.

2. A Textbook of Magnetohydrodynamics by J.A. Shercliff

3. Viscous fluid dynamics by J.L. Bansal

Reference Books:

1. Heat and Mass Transfer by H.D. Baehr and K. Stephan

2.. Convection heat transfer by A. Bejan

Course- III

Group B: Cooperative Games and its Applications to Networks Marks: 60

Unit 1: The Core Marks 12

Core and Dominance; Existence of Core Imputations; balanced collections; lattices and hierarchies; the Weber set; Selectope.

Unit 2: The Shapley value Marks 12

Axiomatizations of the Shapley value; the Potential and the Shapley value; The Banzhaf value.

Unit 3: The Myerson value Marks 12

Characterizations in Communication situations; Characterization in Network Games.

Unit 4: The Position value Marks 12

Characterizations in Communication situations; Characterization in Network Games.

Unit 5: Applications of Cooperative Game Theory in Networks Marks 12

Case studies in social and economic networks

Textbooks:

1. ***Hans Peter, Game Theory - A Multi level Approach, Springer, 2008.***
2. ***Social and Economic Networks by Matthew O.Jackson, Princeton University Press.***

Reference books:

1. ***R.P Gilles, The Cooperative Game Theory of Networks and Hierarchies, Springer 2008.***
2. ***Social and Economic networks in Cooperative Game Theory by Slikker and van dan nouweland.***

Course-III

Group C : Fuzzy sets and Fuzzy Logic

Marks: 60

Unit-1: Marks:15

Fuzzy sets-basic definitions, alpha-level sets, convex fuzy sets, basic operations on fuzzy sets, types of fuzzy sets, Cartesian products, algebraic products, bounded sum and difference, t-norms and t-conorms.

Unit-2: Marks: 15

The extension principle- the Zadeh's extension principle, image and inverse image of fuzzy sets, fuzzy numbers, elements of fuzzy arithmetic.

Unit-3: Marks: 15

Fuzzy relations and fuzzy graphs, composition of fuzzy relations, max-min composition and its properties, fuzzy equivalence relations, fuzzy graphs.

Unit- 4: Marks: 15

Fuzzy logic, fuzzy propositions, fuzzy quantifiers, linguistic variables, inference from conditional fuzzy propositions, compositional rule of inference.

Textbooks:

1. ***D. Dubois and H. Prade, Fuzzy sets and systems: Theory and Applications , Academic Press, New York, 1980.***
2. ***G.J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic : Theory and Applications. Prentice Hall Pvt. Ltd., 2003***

Reference book:

"H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied publishers Ltd., 1991".

Course –III

Group D: Mathematical Theory of Evidence Marks:60

Unit-1: Basic Concepts: Marks: 15

Uncertainty-a taxonomy, Sources of Uncertainty, Nature of Uncertainty, Various Approaches of uncertainty Modeling, Basic Concepts of Evidence Theory, Basic Probability Assignment, Belief and Plausibility Measure and their Properties.

Unit-2: Combination of Evidences: Marks: 15

Dempster's rule of Combinations, Discount + Combine rule, Yager's Rule, Inagaki's rule, Zhang's rule Dubois and Prade rule, Mixing and Averaging rule, other combination rules.

Unit-3: Measure of Uncertainty and Generation of BPA: Marks: 15

Nonspecificity and Strife. Different methods to obtain BPA.

Unit-4: Applications: Marks: 15

Applications of Dempster-Shafer theory of evidence in real world problems.

Textbooks:

1. ***A Mathematical Theory of Evidence by Glenn Shafer, Princeton University Press.***
2. ***Measurement Uncertainty: An Approach via Mathematical Theory of Evidence by Simona Salicone, Springer.***

Reference Book:

"Uncertainty Modeling and Analysis in Engineering and the Sciences by B.M. Ayyub and G.J. Klir, Chapman & Hall/CRC."

Course III

Group E: Theoretical Plasma Dynamics Marks: 60

Unit 1: Introduction Marks: 10

Plasma Definition, History of Plasma, Occurrence of Plasma, Plasma Applications

Unit 2: Characteristics of Plasma Marks: 10

Plasma Temperature, Debye Length, Quasi neutrality, Debye Shielding, Conditions for a gas to be Plasma.

Unit 3: Plasma Waves Marks: 20

Microscopic and Macroscopic study of plasma, Equations Governing Plasma Definitions, Dispersion Relation, Perturbation Theory, Plasma Oscillations, Plasma Electron Oscillations, Ion Waves, Derivation of Ion Acoustic Wave.

Unit 4: Nonlinear Waves in Plasma Marks: 10

Solitons, Double Layer, Sheath, Shock Waves,Basic Equations,Derivation of K-dV Equation.

Unit 5: Kinetic Theory Marks: 10

Introduction,Vlasov Equation,Resonant Interaction,Landau Damping.

TextBook:

"Introduction to Unmagnetized Plasmas " by C. Uberoi, Publisher PHI Learning".

Reference Books:

1. ***"Introduction to Plasma Physics and Controlled Fusion " by F. F. Chen, Springer Publication.***
2. ***"Fundamentals of Plasma Physics" by P. M. Bellan, Publisher Cambridge University Press***

Course : III

Group F : Complex Networks and Graph Measures **Marks: 60**

Unit 1: Preliminaries Marks : 20

Basics of Graph Theory, Network approach to Nature, Four general classes:
Technological networks, Social Networks , Information networks, and Biological networks,
Random Networks, Real-world Networks, Examples.

Unit 2: Models of Complex Network Marks:20

Generalized Random Graphs, Milgram Experiment ,Six degrees of separation, Small world Network, Old Tales of Tails, New Tales of Tails, Power Laws, Preferential Attachment Model.

Unit 3 : Measures and Metrices Marks : 20

Centrality Measures, Spectral Measures: Degree Distribution, Correlations, Shortest Path Lengths, Diameter, Closeness, Betweenness, Clustering Coefficient, Page Rank, Efficiency,
Graph Spectra.

Textbooks:

1. ***M.V. Steen, Graph Theory and Complex Networks: An Introduction,2010.***
2. **R.Cohen, S.Havlin, Complex Networks: Structure, Robustness and Function, Cambridge University Press,2010.**

Reference Books*:*

1. ***E.Estrada, The Structure of Complex Networks: Theory and Applications, Oxford University Press,2011***
2. ***M.E,J.Newman, Networks: An Introduction, Oxford University, Press.2010.***
3. ***A-L Barabasi, Network Science, Cambridge Universtiy, Press 2016.***

Course : III

Group G : Introduction to Mathematical Biology **Marks: 60**

Unit 1: Fundamentals of Mathematics in Biology Marks 15

The Intersection of Biology and Mathematics, Historical Developments, The Role of Biomathematics in Modern Science.

Unit 2: Statistics in Biology Marks 20

Descriptive Statistics in Biology, Hypothesis Testing and Significance, Correlation and Regression Analysis.

Unit 3: Fundamentals of Mathematics in Protein Synthesis Marks:25

Basics of DNA sequencing, Sequence alignment algorithms, Identifying mutations and variations, the genetic code and its mathematical properties, Codon usage bias, Evolution of the genetic code, Role of mathematics in molecular biology.

Textbooks:

1. ***Allman, E S, and John A. R. Mathematical models in biology: An introduction. Cambridge University Press, 2004.***
2. ***Durbin, R. et al. Biological sequence analysis: probabilistic models of proteins and nucleic acids. Cambridge university press, 1998.***

Reference Books:

1. ***Norman, G R., and David L. S. Biostatistics: the bare essentials. PMPH USA (BC Decker), 2008.***
2. ***Mandoiu, Ion, and Alexander Zelikovsky. Bioinformatics algorithms: techniques and applications. Vol. 3. John Wiley & Sons, 2008.***

Course : III

Group H : Advanced Functional Analysis Marks: 60

Unit I: Topological vector spaces, Separation properties, Finite-dimensional spaces, Metrization, Boundedness and continuity, Semi-norms and local convexity, Bilinear mappings, Convexity, Weak topologies, Compact convex sets. Marks 15

Unit II: Basics of Banach algebra and C*algebra, Commutative Banach algebras and C*- algebras, Representation of C*-algebras. Marks 15

Unit III: Spectral theory of linear operators in normed space, Spectral properties of bounded linear operators, Further properties of resolvent and spectrum, Compact linear operator on normed spaces with spectral properties, Spectral properties of bounded self-adjoint linear operators. Marks 15

Unit-IV: Banach fixed point theorem, Applications to linear equation, Differential and Integral equations. Marks 15

Textbooks:

1. ***Kreyszig E., Introductory Functional Analysis with Applications (John Wiley and Sons, New York, 1978).***
2. ***Rudin, W. Functional Analysis (McGraw Hill, 2000).***
3. ***Simmons, G. F. Introduction to Topology and Modern Analysis (Tata McGraw Hill Book Co. Ltd., 1963).***
4. ***Gerard J. Murphy, C* - Algebras and Operator Theory, Academic Press, Inc, 1990***

Reference books:

1. ***Ronald G. Douglas, Banach Algebra Techniques in Operator Theory, Second Edition, Springer-Verlag, New York, Inc, 1998.***
2. ***Limaye, B. V. Functional Analysis (Wiley Eastern Ltd., New Delhi, 1989).***

COURSE IV : **DISSERTATION (Under guidance of the Supervisor concerned) and VIVA-VOCE**

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