DEPARTMENT OF MATHEMATICAL SCIENCES
BODOLAND UNIVERSITY, KOKRAJHAR
BTC, ASSAM
SYLLABUS FOR Ph. D COURSE WORK
IN
MATHEMATICS
2021

For successful completion of the one Semester (6 months) Ph. D. Course work which is compulsory for all the research scholars will have five papers. First four papers shall be of total 12 credits having three credits per paper while fifth paper will carry two credits. Thus there will be a grand total of 14 credit course. Total marks in each paper shall be 100 (20 marks for sessional, 80 marks for end semester examination).

The 5 (Five) Papers are

Paper-I: Research Methodology [Total Marks 100(80+20)]
Paper-II: Computer Application [Total Marks 100(80+20)]
Paper-III: Overview on relevant Subject Paper [Total Marks 100 (80 For Dissertation) + 20 (For Seminar Presentation)]
Paper-IV: In depth of the relevant Subject Paper/Research area [Total Marks 100(80+20)]
Paper-V: Research and Publication Ethics

In the above 5(Four) Papers, Paper I, II and V are compulsory for all the research scholars, but Paper III and IV shall be subject specific related to the research area. So these two papers will be Optional as per the availability of Research guide in the concern department.

Details of Syllabus

Paper I: Research Methodology:

Meaning, purpose of Research Methodology; objectives and motivation of research, phases of research, Research approaches and related tools, Conditions and criteria for good research. Formation of research problem, accuracy of definition; preparation of research article and thesis, Research proposals, Factors leading to the choice, defining the concrete research problem and focusing on it Technique involved in defining a problem, Importance of communication skill in Research- Development of power of expression in both speaking and writing, Mastery of presentation techniques. Progress report; Research Ethics and Morals Issues related to plagiarism, collaborative models and ethics, acknowledgements. Intellectual Property Rights: copy rights, copy left: patents.

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Reference Books :

1. Research methodology: Methods and Techniques C. R. Kothari New age international 2005
2. Introduction to research, Tynes Hillway Houghton Wiffin Company
3. J. N. Kapur: Research Methodology: Willey Eastern Ltd.

Paper II: Computer Application:

Unit I : **Marks 20**

Operating system, System Software, Application Software, Use of Microsoft office word in word processing, graphical presentation and preparation of documents. Power Point in graphical presentation and preparation of documents, Creating and printing a presentation, producing a slide show, Excel in data analysis, Editing and formatting worksheets, performing basic calculations, working with charts. Browsing internet for related literature and Inter Groups for sharing of data and result.

Unit II: **Marks 30**

Types of Software: Spreadsheets, Statistical Packages, Specialized Demographic Software Software knowledge: SPSS, R-Language.

Basics of SciLab, Python.

Unit III: **Marks 30**

Producing and preparation of Mathematical documents using Microsoft-Words and Latex. Producing Simple Documents using LATEX, Producing Mathematical equations and formulae using Math type and LATEX, Article and thesis writing technique in LATEX.

Reference Books:

1. https://www.tutorialspoint.com/word/word_tutorial.pdf
2. https://onlinecourses.swayam2.ac.in/cec20_cs05/preview
3. Computer Fundamentals by P.K. Singha, Priti Singha
4. Peter Norton “Introduction to Computers” , 6th International Edition (McGraw Hill)
5. S. Wolfrom: The Mathematica Book(Cambridge University Press), 4th Edition,(2001)
6. The Not So Short Introduction to LATEX 2E by Tobias Oetiker Hubert Partl, Irene Hyna and Elisabeth Schlegl Version 4.17, September 27, 2005
7. L. Lampart, LaTex: A Document Preparation System-User’s Guide and Reference Manual, Pearson Education Inc. 7thEdn. New Delhi, (2005).
8. G. Gratzer, Math into LaTex, Springer, New York, 3rdEdn. (2000).

Paper-III: Overview on relevant Subject Paper
[Total Marks 100(80(For Dissertation) +20(For Seminar Presentation)]

Paper-IV: In depth of the relevant Subject Paper/Research Area
[Total Marks 100(80+20)]

Any one from the following Papers:

(a) RELATIVISTIC COSMOLOGY

Unit-I: Cosmology, Mach's principle, Einstein field equations with cosmological term. Hubble's law, cosmological principles, Weyl's postulate, Friedmann-Robertson-Walker metric, Friedmann models Critical density, Closed and open Universe, Age of Universe.

Unit-II: Matter dominated era of the Universe, Particle and even horizons, Perfect cosmological principle, Brans –Dicke theory, early universe, Inflation, dark energy, dark matter, present cosmic acceleration.

Unit-III: Compact Stars, White dwarfs, internal structure, Gravitational Collapse and Black Holes, Spherically symmetric collapse of a dust cloud, general properties of black Holes, Stationary Black holes, critical mass, types of black holes.

Reference Books:

1. H Stepheni, General Relativity: An introduction to the theory of the gravitational field, Cambridge university Press,1982
2. J. V. Narlikar,General Relativity and Cosmology,Macmillan Company of India ltd.
3. S Weinberg: Gravitation and cosmology: Principles and Applications of the general theory of relativity,John Wiley & Sons, Inc.1972.

(b) *L*-FUZZY TOPOLOGY:

Unit-I: Basic definitions and properties of fuzzy sets, Comparison of fuzzy set systems with classical set theory. Several approaches towards the definitions of fuzzy topology: Chang, Lowen etc. Various properties of Continuous functions, Open and Closed functions, Separation axioms in fuzzy topological spaces.

Unit-II: Posets, Isomorphism, Lattices, Properties of Lattice, distributive lattices, Infinite Distributivity, Complete Lattice, product of lattices.

Unit-III: Definitions of *L*- fuzzy sets and *L*-topology, Compactness, Connectedness, Separation axioms, Metrization theorems in *L*- fuzzy topological spaces, Product Spaces, *L*-fuzzy Uniform Spaces.

Reference Books:

1. Gratzer: Distributive Lattices-Basic Concepts(Freeman and Co.)
2. Birkhoff: Lattice TheoryAmer.Math.Soc.Collg.Pub.no.25
3. Y. M. Liu and M. K. Luo, Fuzzy Topology, Advances in Fuzzy Systems – Applications and Theory,vol.9, World Scientific, 1997.
4. N. Palaniappan, Fuzzy Topology, Alpha Science International, 2005.

(c) FUZZY MATHEMATICS

Unit I: Fuzzy sets – basics definitions, α-level sets, convex fuzzy sets, basic operations on fuzzy sets, types of fuzzy sets, Cartesian products, algebraic products, bounded sum and difference, t-norms and t-conorms. Fuzzy sets in contrast of probability theory.

Unit II: The extension principle – the Zadeh's extension principle, image and inverse image of fuzzy sets, fuzzy numbers, elements of fuzzy arithmetic.

Unit III: Fuzzy relations and fuzzy graphs, composition of fuzzy relations, min – max composition and its properties, fuzzy equivalence relations, fuzzy relation equations, fuzzy graphs.

Unit IV: Several Approaches towards the definition of fuzzy topology: Chang, Lowen etc. Basic properties of continuous functions, open and closed functions, separation axioms in fuzzy topological spaces.

References:

1. Zimmermann, H.J., *Fuzzy set theory and its Applications*, Allied publishers Ltd., New Delhi 1991.
2. Klir, G.J. and Yuan, B., *Fuzzy sets and fuzzy logic; Theory and Applications*, Prentice Hall of India, New Delhi, 1997.
3. N. Palaniappan, *Fuzzy topology*, Alpha Science international, 2005.

(d) GRAPH THEORY

Unit-I:

1.1 : Intersection of graph , degree sequence
1.2 : Basic concepts of factorization, 1-factorization
1.3 :2-factorization, Arboricity
1.4 : Covering and independence and their properties

Unit II:

2.1: Basic of Matchings, perfect matching, Augmenting paths, maximum matching

2.2: Domination concepts and other variants: Dominating sets in graphs , domination of number of standard graphs , minimal dominating set
2.3: Bounds of domination number in terms of size , order, degree , diameter, Domatic number, domatic number of standard graphs

Unit III:

3.1: Plane and planar graphs, Euler identity, Non planar graphs, maximal planar graph, Outer planar graphs, maximal outer planar graphs.

3.2: Vertex Coloring, Color class, n-coloring, Chromatic index of a graph, Colorings in critical graphs, relation between chromatic number and clique number/independence number/ maximum degree.

3.3:Edge coloring, Edge chromatic number of standard graphs Coloring of a plane map

Unit IV:

4.1: Oriented graph , indegree and outdegree, elementary theorems in diagraph, types of digraph

4.2: Matrix representation, the adjacency matrix

4.3; The incidence matrix and the cycle matrix

Unit V:

5.1:Basic of hypergraph

5.2 Some basic properties of hypergraph, Applications of hypergraghs,

5.3 Basic of Semigraphs, examples of semigraphs

5.4 Basic properties of semigraphs

References:

1. Graph Theory, F. Harary, Narosha Publishing Co.
2. Graphs and Hypergraphs, C. Berge, North-Holland , London(1973)
3. Hypergraphs, C. Berge, Notrth-Holland, London (1973)
4. Combinatorial Optimization,
5. Introduction to Graph Theory, D. B. West, Prentice-Hall (2001)

(e) FUNCTIONAL ANALYSIS

Unit I: Spectral theory of Linear operators in normed , spaces, spectral theory in finite dimensional nomerd spaces, spectral properties of bounded linear operators, Further properties of resolvent and spectrum , Use of complex analysis in spectral theory, Banach Algebras, c* algebras and further properties

Unit II: Compact linear operators on normed spaces and their spectrum, compact linear operators on normed spaces , further properties of compact linear operators, spectral properties of compact linear operates on normed spaces, further spectral properties of compact linear operators, operator equations involving compact linear operators.

Unit III: Spectral theory of bounded, self-Adjoint linear operators , spectral properties of bounded Self-Adjoint linear operators, Further spectral properties of bounded self-Adjoint, linear operators , positive operators , square roots of a positive operator , projection operator , further properties of projection, spectral family , spectral family of a bounded self adjoined d linear, operator, spectral

representation of bounded self adjoined linear operators , extension of the spectral theorem to continuous functions, properties of the spectral family of a bounded Self-Adjoint linear operator.

Text Books:

1. Kreyszig E., Introductory Functional Analysis with Applications (John Wiley and Sons, New York , 1978)
2. Lipschutz S., Lipson M., Schaum's Outline linear algebra, Mc Grow Hill, 3rd Edition

References:

1. Limaye, B. V. Functional Analysis (Wiley Eastern Ltd., New Delhi, 1989)
2. Rudin, W., Functional Analysis (McGraw Hill 2000)
3. Halmos, P. R., Linear Algebra Problem Book, The mathematical Association of America (MAA), USA, 1995.
4. Halmos, P. R. , Finite dimensional Vector spaces , Springer Verlag, New York,1987
5. Simmons, G.F., introduction to Topology and Modern Analysis (Tata McGraw Hill Book Co. Ltd. , 1963)

(f) METHODS OF DEMOGRAPHIC ANALYSIS

Unit I: Introduction to Demography **20 marks**

Concept, Nature and Scopeof Demography, Population Studies, development and necessity of Population Studies in India (with special reference to Assam), Theories of Population:Ancient Writings on Population– Chinese, Greek and Roman, Pre- and Post-Malthusian Theories, Optimum Population Theory, Theory of Demographic Transition.

Unit II:Demographic Information **20 marks**

Nature of Demographic Information, Components of Population Change, Demographic Change and Implications.

Data,Data Sourcesand Collection Methods:Data and its types, Qualitative and Quantitative data, Sources of data- Primary, Secondary and Tertiary sources, Methods of data collection, Population and Sample.

Sources of Population Data: Population Census, Registration of Vital Statistics, Sample Surveys,Population Registers, Administrative Records, Demographic Data from International Agencies.

Unit III: Elements of Demographic Analysis **20 marks**

Balancing Equation, Population Growth Rates:Annual Growth Rate, Exponential Population Growth Rate, Interpolation and Extrapolation, Population Doubling Time, Growth and Fold rates;Population Dynamics and Analytical Approaches- Demographic Stocks and Flows, Cross-Sectional and Longitudinal Approachesin Demography, Synthetic Measures; Crude Rates; Characteristic-Specific Rates and Ratios: Characteristic-Specific Rates, Sex Ratios,

Sex Ratio at Birth, Child-Woman Ratio, Dependency Ratio, Child to Old Ratios; Population Density and Distribution: Population Density, Index of Redistribution, Index of Concentration; Impact of Characteristics on Demographic Measures; Direct and Indirect Standardization, Graphical Presentation of Demographic Data.

Unit IV: Principal determinants of population change **20 marks**

Fertility: Perspectives on Fertility, Cross-Sectional Fertility Rates: Crude Birth Rates, Age-Specific and General Fertility Rates; Cross-Sectional and Longitudinal Fertility; Synthetic Measures of Fertility: Total Fertility Rate, Gross and Net Reproduction Rates, Mean Length of Generation, Synthetic Measures Using Grouped Data, Other Formulae for Synthetic Measures; Fertility Rates and Population Characteristics, Parity and Parity Progression Ratios, Standardized Fertility Ratios, Maximum Biological Fertility.

Mortality: Cross-Sectional Mortality Rates- Crude Death Rates, Age-Specific Mortality Rates; Longitudinal Mortality Rates, Causes of Death, Maternal Mortality, Foetal and Early Childhood Mortality: Perinatal, Neonatal and Infant Mortality, Abortion Rates and Ratios; Characteristic Specific Mortality Rates: Mortality and Place of Birth, Mortality and Marital Status.

Migration: Basic Concepts, Migration Rates and Ratios: Crude Migration Rates, Characteristic-Specific Migration Rates, Migration Ratios; Direct Methods of Estimation: Place of Residence at Specific Times in the Past, Place of Birth; Indirect Methods of Estimation: Census Survival Ratios, Other Administrative Records; Determinants of Migration: Push and Pull Factors, Gravity Model; Centre of Gravity of Population.

Social and Economic Factors affecting Fertility and Mortality, Causes and Consequences of migration.

Suggested Readings: -

1. Foundation of Statistics, O. P.Bajpai, Asia Publishing House.
2. Introduction to the Mathematics of Population, Nathan Keyfitz, Addison-Wesley Publishing Company.
3. Demography and Population Studies, O. S. Shrivastava, Quality Publishing Company
4. Methods of Demographic Analysis,Farhat Yusuf, Jo. M. Martins and David A. Swanson, Springer Publications.
5. Research Methodology Data Presentation, Y. K. Singh, R. B. Bajpai, APH Publishing Corporation.
6. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, SAGE Publications
7. ResearchMethodology: Methods & Techniques, C. R. Kothari, New Age International Publishers

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Course structure

- The course comprises of six modules listed in table below. Each module has 4-5 units.

Modules	Unit title	Teaching hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Databases and Research Metrics	7
	Total	**30**

Syllabus in detail

THEORY

- **RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)**

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

- **RPE 02: SCIENTIFICCONDUCT (5hrs.)**

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

- **RPE 03: PUBLICATION ETHICS (7 hrs.)**

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

- **RPE 04: OPEN ACCESS PUBLISHING(4 hrs.)**

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

- **RPE 05: PUBLICATION MISCONDUCT (4hrs.)**

A. Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2 hrs.)

Use of plagiarism software like Turnitin, Urkund and other open source software tools

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

A. Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3 hrs.)

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics

References

Bird, A. (2006). *Philosophy of Science*. Routledge.

MacIntyre, Alasdair (1967) *A Short History of Ethics*. London.

P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865

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.

Resnik, D. B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences*, 1–10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179–179. https://doi.org/10.1038/489179a

Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf