DEPARTMENT OF MATHEMATICS

Scheme & Syllabi
Ph.D. course work in Mathematics

W.E.F. 2020-21

CENTRAL UNIVERSITY OF HARYANA
JANT-PALI, MAHENDERGARH
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Department of Mathematics

Central University of Haryana
Mahendergarh, Haryana-123031

Scheme and Syllabus of Ph.D. Mathematics
(CHOICE BASED CREDIT SYSTEM)

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Course Type

Core Course (C)
Discipline Centric Elective Course (E) of subject specific.

Total Credit: 14

Each candidate is required to take core courses and one elective course of subject specific.

S. No.	Course Code	Course Title	Credits	Course Type
1.	SBS MAT 02 01 01 C 6006	Research Methodology	6	Core
2.	SBS MAT 02 01 02 C 2002	Research and Publication Ethics	2	Core
3.	SBS MAT 02 01 01 E 5106	Topics in Pure Mathematics	6	Elective
4.	SBS MAT 02 01 02 E 5106	Topics in Applied Mathematics	6	Elective
5.	SBS MAT 02 01 03 E 5106	Topics in Advanced Mathematics	6	Elective

Research Methodology

(SBS MAT 0**2** 01 01 C 6006)

End SemesterExamination:60
Internal Assessment:40
Total:100

Course Objectives:
To familiarize the students with general techniques of performing analysis of data and modelling using various simulation techniques. This course will enable students to design experiments and methods to extract data.

Learning Outcomes:

- To motivate students for research in different fields of Physics, Mathematics and Statistics.
- To teach students different techniques of research modelling, data collection, designing and planning of experiments.
- To enable to analyze data and write report based on data analyzed.

UNIT I

Research Problems: Meaning, Motivation, Objectives and types of research, Significance of research, Research proposals and aspects, Criteria of good research, Research formulation and hypotheses, Selection and necessity of defining the problem, Literature review, Primary and secondary sources, Reviews, Treatise, Monographs, Patents.

UNIT II

Research Design: Need, Problem Definition, Variables, Research design concepts, Research design process, Research Modeling: Types of models, Model building and stages, Data collection, processing and analysis, Simulation techniques using computer software(s).

UNIT III

Design and Planning of Experiments: Aims and objectives, expected outcome, methodology to be adopted, importance of reproducibility of research work, Interpolation, Extrapolation, Types of errors (rounding, truncation, machine and random), Error analysis and least square curve fitting. Analysis of Variance components (ANOVA) for fixed effect model, Objectives and basic principles of designs of experiments. Complete randomized design (CRD), Randomized block design (RBD) and Latin square design (LSD).

UNIT IV

Data mining and Report Writing: Library resources, Internet, Scientific search engines, Introduction to Latex/Google docs, Structure and component of research paper, Presenting the research paper/thesis, Journal impact factor, Citation index, References and bibliography, Copyright, Plagiarism and ethics in research, Communication and presentation.

Suggested Readings:

1. Kothari, C. R. and Garg, G., Research Methodology: Methods and Techniques, 3rd edition, New Age International Publishers, New Delhi, 2014.
2. Prathapan, K., Research Methodology for Scientific Research, IK International, New Delhi, 2014.
3. Montgomery, D.C., Design and Analysis of Experiments, 8thedition, Wiley India, 2013.
4. Pannerselvan, R., Research Methodology, Prentice Hall of India, New Delhi, 2009.
5. Singh, Y.K., Fundamental of Research Methodology and Statistics, New Age International Publishers, New Delhi, 2008.

Research and Publication Ethics

(SBS MAT 0**2** 01 02 C 2002)

End Semester Examination: 60

Internal Assessment: 40

Total: 100

Course Objectives:
The course aimed is to aware the students about the basic ethics of research and publication. The contents will serve as basic tools to groom the students about plagiarism in research.

Learning Outcomes:

On completion of the course, the student should be able to:

- Understand the basic ethics of research.
- Maintain the research integrity and intellectual honesty.
- Understand the scientific misconduct and proper citations.
- Acquire knowledge of databases and software's.

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: Scientific Conduct (5 hrs.)

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 guidance: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour 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 polices
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 (4 hrs.)

A. Group Discussion (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.)

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

RPE 06: Databases and Research Metrics (7 hrs.)

A. Databases (4 hrs,)

1. Indexing databases Research Metrics
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, IIP, Cite Score
2. Metrics: h index, g index, i10 index, almetrics

Suggested Readings:

1. 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

2. Chaddah, P., Ethics in Competitive Research: Do not get scooped; do not get plagiarized 2018, ISBN:978-9387480865.
3. Beall, J. Predatory publishers are corrupting open access, Nature, 489 (7415), 179-179, 2012. https://doi.org/10.1038/489179a

4. Resnik, D. B., What is ethics in research and why is it important, National Institute of Environmental Health Sciences, 1-10. Retrived from https://www.neihs.nih.gov/research/resources/bioethics/whatis/index.cfm 2011.
5. National Academy of Sciences, National Academy of Engineering and Institute of Medicine, On Being a Scientist: A Guide to Responsible Conduct in Research: 3rd edition , National Academics Press 2009.
6. Bird, A., Philosophy of Science, Routledge 2006.
7. MacIntyre, A., A Short History of Ethics, London 1967.

Topics in Pure Mathematics

(SBS MAT 02 01 01 E 5106)

End Semester Examination: 60
Internal Assessment: 40
Total: 100

Course Objectives:
To familiarize the students about the general concepts of pure mathematics including some advanced topics. To provide an understanding of measure theory, advanced complex analysis, Banach spaces and C*-algebra.

Learning Outcomes:
On completion of the course, the students should be able to:

- Learn and apply the Lebesgue integration, Fatou's lemma and Radon-Nikodym theorem.
- Understand the complete characterization of analytic functions.
- Use Hahn-Banach theorem and its applications to various concepts.
- Understand the basic of Gelfand mapping, Banach-algebra and C*-algebra.

UNIT I

Concept of measure, Lebesgue outer measure and measurable sets, sigma algebra, Borel sets, G_δ and F_σ –sets, outer and inner regularity of Lebesgue measure, the Lebesgue integration of a measurable function, integration with respect to a measure, convergence in measure, Fatou's lemma, monotone and dominated convergence theorems, Jensen's inequality, Radon-Nikodym theorem, Fubini's theorem.

UNIT II

Hadamard's three circles theorem, Phragmen-Lindelof theorem, the space of continuous functions, spaces of analytic functions, the Riemann mapping theorem, Weierstrass factorization theorem, Gamma function, Reimann zeta function, Harmonic functions on a disk, Jensen's formula, Bloch's theorem, the Little Picard theorem, Schottky's theorem, the Great Picard theorem.

UNIT III

Banach space definition and some examples, continuous linear transformations, the Hahn-Banach theorem, the natural imbedding of *N* in *N***, the open mapping theorem, conjugates of an operator, Hilbert space definition and some properties, orthogonal properties and linear operators.

UNIT IV

Definition and some examples of Banach algebra, regular and singular elements spectrum, formula for spectral radius, the radical and semi simplicity, the structure of commutative Banach algebras, the Gelfand mapping, involutions in Banach algebras, the Gelfand-Neumark theorem, ideal in C(X) and Banach-Stone theorem, commutative C*-algebra.

Suggested Readings:

1. Royden, H. L., Real Analysis, MacMillan Publishing Co., Inc., New York, 8th edition, 2018.
2. Ahlfors, L.V., Complex Analysis, McGraw-Hill, 3rd edition, 2017.
3. Mathews, J. H. and Howell, R. W., Complex Analysis for Mathematics and Engineering, Jones & Bartlett Publishers, 2012.
4. Barra, G.de.,Measure Theory and Integration, New Age International (P) Ltd., 2009.
5. Rana, I. K., An Introduction to Measure and Integration, Narosa Publishing House, 2nd edition 2004.
6. Conway J. B. Functions of One Complex Variable, Springer, 1978.

Topics in Applied Mathematics

(SBS MAT 02 01 02 E 5106)

End SemesterExamination:60
Internal Assessment:40
Total:100

Course Objectives:
The course is aimed to develop the basic mathematical skills of research students in applied mathematics. The topics introduced will serve as basic tools for specialized studies in many fields of applied mathematics.

Learning Outcomes:

On completion of the course, the students should be able to:

- Differentiate between finite element and finite difference methods.
- Use the concept of shape functions in solutions of boundary value problems.
- Implement advanced aspects of various mathematical transforms.
- Understand the concepts of linear programming problems.

UNIT I

Review of finite difference method, introduction to finite element methods, difference between finite element and finite difference methods, method of weighted residuals: collocation, method of least squares, Galerkin's method, Ritz method.

UNIT II

Linear, quadratic and higher order elements, construction of shape functions: Linear elements (One dimensional bar element, two dimensional-Triangular and rectangular elements, three dimensional tetrahedron element). Assembly of element equations and their solution, application of finite element methods for solving various boundary value problems.

UNIT III

Integral transform: basic concepts of integral transforms. Laplace transform, Fourier transform, Mellin transforms, Hankel transform, Hermite transform, Hartley transform, Radon transform and wavelet transform.

UNIT IV

Linear Programming Problem: Simplex algorithm- two Phase method, the Big-M method, dual simplex method, duality in linear programming, sensitivity analysis. Transportation problem: mathematical model, variations in transportation problem, maximization & transshipment problems, integer programming problem, limitations of integer programming, Advantage of integer programming.

Suggested Readings:

1. Gupta, R. K.,Numerical Methods: Fundamentals and Applications, Cambridge University Press, 2019.
2. Lokenath, D. and Dambaru, B., Integral Transforms and Their Applications, 3rd edition, CRC Press, 2014.
3. Larson, M. G. and Bengzon, F., The Finite Element Method: Theory, Implementation, and Applications, Springer, 2013.
4. Davies, B., Integral Transforms and Their Applications, Springer New York, 2013.
5. Taha, H. A., Operations Research-An Introduction, , 9th edition, Prentice Hall, 2010.
6. Hughes, T. J. R., The Finite Element Method, Courier Corporation, 2007.
7. Jain, M. K., Numerical Solution of Differential Equations. New Age International (P) Ltd, 2003.
8. Hadley, G., Linear Programming, Reprint, Narosa, 2002.
9. Zienkiewicz, O. C. and Taylor, R. L., The Finite Element Method: The Basis. Butterworth-Heinemann, 2000.

Topics in Advanced Mathematics

(SBS MAT 02 01 03 E 5106)

End SemesterExamination:60
Internal Assessment:40
Total:100

Course Objectives:
To familiarize the students about recent advancements in mathematics including graph theory, wavelets and reliability theory.

Learning Outcomes:

On completion of the course, the student should be able to:

- Understand the concepts of Lattice, Boolean algebras and graph theory.
- Use the concept of wavelet theory in signal and image processing.
- Develop reliability models for different configurations along with reliability assessment.

UNIT I

Lattices and Boolean algebra, lattices as a partially ordered sets, some properties of lattices, lattices as algebraic systems, sublattices, direct product and homomorphism special lattices Boolean algebra, Boolean functions, representation and minimization of Boolean functions, graphs isomorphism, sub graphs, Euler graphs, Hamiltonian paths and circuits travelling salesman problem.

UNIT II

Trees, properties of trees, spanning trees, minimal spanning trees, Kruzkal's algorithm, Premis algorithm, Dijkstra's algorithm, cut-sets and cut-vertices, planar graph, duality in planner graphs, matrix representation of graphs incidence matrix, adjacent matrix path matrix, circuit matrix, cut set matrix, transitive closure or a graph Warshall's algorithm, coloring covering and partitioning, chromatic number, chromatic partitioning, chromatic polynomial matching, coverings the four color problem.

UNIT III

Introduction stationary and non-stationary signals, signal representation using basis and frames, time-frequency analysis. Bases of time frequency: orthogonal, filter banks. Multi resolution formulation: wavelets from filters, classes of wavelets: Haar, Daubechies. Matrix decomposition techniques: LU decomposition, Cholesky decomposition, QR decomposition, singular value decomposition.

UNIT IV

Definition of reliability: definition of terms used in reliability, component reliability, hazard rate, derivation of the reliability function in terms of the hazard rate, hazard models, bath tub curve, effect of preventive maintenance. Measures of reliability: mean time to failure and mean time between failures, evaluation of reliability/unreliability, series systems, parallel systems- series-parallel systems, partially redundant systems with examples.

Suggested Readings:

1. Rosen, K. H., Discrete Mathematics and Its Applications, 7th edition, Tata McGraw Hill, 2017.
2. Ram, B., Discrete Mathematics, Pearson Education, 2012.
3. Goswami, J. C. and Chan, A. K., Fundamentals of Wavelets: Theory, Algorithms, and Applications, 2nd edition, Wiley, 2011.
4. Misiti, M., Misiti, Y., Oppenheim, G. and Poggi, J. M., Wavelets and Their Applications, John Wiley & Sons, 2010.
5. Balagurusamy, E., Reliability Engineering, Tata McGraw-Hill Publishing Company Limited, 2002.
6. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, S. Chand and Sons, 2000.
7. Trembley, J. P. and Manohar, R., A First Course in Discrete Structure with Applications to Computer Science, Tata McGraw Hill, 1999.
8. Trefethen, L. N. and Bau, D., Numerical Linear Algebra, Society for Industrial and Applied Mathematics, 1997.
9. Agarwal, K. K., Reliability Engineering-Kluwer Academic Publishers, 1993.
10. Billinton, R. and Allan, R. N., Reliability Evaluation of Engineering Systems, Plenum Press, 1983.