

Syllabus of Ph.D Course work
[2020-21]



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Syllabus of Ph.D Course work in Mathematics

COURSE STRUCTURE

PAPER NO.	PAPER NAME	MARKS	CREDIT
M701	Research Methodology	100	6
M702	Recent Advance in the concerned subject	100	6
M703	Research and Publication Ethics	50	2
M704	Literature Review Related to Proposed Topic	100	6
M705	Preparation of Research Proposal/Synopsis	50	4
TOTAL		400	24

Detail Syllabus

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M701	Research Methodology	6	40	60

Objectives	The basic objective of this course is to introduce students about the knowledge on back ground of research such as data collection, analysis, error calculation and computer calculation.
Pre-Requisites	Knowledge on basic concept of research and computer handling.
Course Outcome	On successful completion of the course students known the various concepts of research and data collection as well as copy right and able to known computer based calculation and paper writing.
Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students.

Unit	Topics	Hours
I	Motivation and objectives – Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.	10
II	Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews,. Research design – Basic Principles- Need of research design — Features of good design	10
III	Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.	10
IV	Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.	10
V	Basic of Computer Operating System: Using Windows – Directory structures – command structure (Document preparation, EXCEL, Power Point Presentation). Word Processing: Basics of Editing and Word processing. Web Browsing for Research: Usage of Webs as a tool for scientific literature survey.	8
Total		48

Reference:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications.2 volumes.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M702	Recent Advance in the concerned subject	6	40	60

Objectives	The basic objective of this course is to introduce students about the knowledge on back ground of research and their core subject
Pre-Requisites	Knowledge on basic PG level Mathematics
Course Outcome	On successful completion of the course students can build their foundation to work on their respective core subject
Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students.

Detail Syllabus: As per the specialization of supervisor

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M702	Advance <i>numerical analysis</i>	8	40	60

Objectives	Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various methods of finding solution of different type of problems such as locating roots of equations, finding solution of nonlinear equations, systems of linear equations, differential equations, Interpolation and approximation, differentiation, evaluating integration so as to minimize the error and time required to solve the problem and to evaluate approximate eigenavlues by using different methods.
Pre-Requisites	Basic Mathematics
Course Outcome	After getting trained a student can opt for the courses like advanced Numerical analysis and numerical functional analysis. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.
Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students. Home assignments.

Unit	Topics	Hours
I	Error Analysis: Exact and approximate numbers, Rounding of numbers, Significant digits, Correct digits, various types of errors encountered in computations, Propagation of errors.	10
II	Solution of system of linear equations: (i) Direct methods: Gauss elimination method without pivoting and with pivoting, LU-decomposition method. (ii) Iterative methods: Jacobi and Gauss-Seidel methods. Roots of non-linear equations: Newton-Raphson method for solution of a pair of non-linear	10

	equations.	
III	Eigen values and Eigen vectors: Dominant and smallest Eigen values/Eigen vectors by power method. Interpolation: Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation.	10
IV	Numerical differentiation: First and second order derivatives by various interpolation formulae. Numerical integration: Trapezoidal, Simpsons 1/3rd and 3/8th rules with errors and their combinations,	10
V	Gauss Legendre 2-points and 3-points formulae Solution of first and second order ordinary differential equations: Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.	8
Total		48

Text Book

1. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi-2019
2. Gerald, C. F. and Wheatly, P. O., " Applied Numerical Analysis", 6th Edition, Wesley, 2002

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M702	Coding Theory	8	40	60

Objectives	Study various type of codes, learn the coding problem, find the weight enumerator of codes
Pre-Requisites	Vector space, finite field
Course Outcome	Understand basic concepts and techniques in coding theory, Demonstrate knowledge of encoding and decoding procedure, Learn important families of algebraic codes, graphical codes and convolutional codes
Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students. Home assignments.

Detailed Syllabus

Unit	Topics	Hours
I	The communication channel, the coding problem, Block codes, Hamming metric, Nearest neighbour decoding, Linear codes, Generator and Parity-check matrices, Dual code, Standard array decoding, Syndrome decoding	10
II	Hamming codes, Golay codes, Reed-Muller codes, Codes derived from Hadamard matrices.	08
III	Bounds on codes: Sphere packing bound, Perfect codes, Gilbert-Varshamov bound,	10

	Singleton bound, MDS codes, Plotkin bound	
IV	Weight distribution of codes, MacWilliams Identities. Algebra of polynomials, Residue class rings, Finite fields, Cyclic codes, Generator polynomial and check polynomial, Defining set of a cyclic code, BCH bound, Encoding and decoding of cyclic codes	10
V	Hamming and Golay codes as cyclic codes, BCH codes, Reed-Solomon codes, Quadratic residue codes, Graphical codes, Convolutional codes	10
Total		48

Text Books:

T1. S. Ling and C. Xing: Coding Theory: A First Course, Cambridge University Press.

T2. F.J. MacWilliams and N.J.A. Sloane: The theory of error correcting codes, North Holland Pub.

Reference Books:

R1. V. Pless: Introduction to the theory of error correcting codes, John Wiley.

R2. W.C. Huffman and V. Pless: Fundamentals of error correcting codes, Cambridge University Press.

R3. R.M. Roth: Introduction to coding theory, Cambridge University Press.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M702	Mathematical Finance	8	40	60

Objectives	The aim of this course is to provide grounding in financial mathematics like simple interest, compound interest and their simple applications to calculate accumulate value, present value and loan calculation, project evaluation, calculation of bond price in tax environment, Investment decision, and idea of stochastic interest rate model.
Pre-Requisites	Set theory, Relation Functions, Probability Theory
Course Outcome	On successful completion of the course students will learn to how to invest in market.
Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students. Home assignments.

Unit	Topics	Hours
I	Introduction and overview of financial securities: Equities, fixed income securities, forwards, futures. Forward and Future contracts valuation: Measuring interest rates, Forward price of an investment asset, valuing Forward contracts, stock. Hedging with futures: Minimum variance hedge ratio; hedging with stock index futures.	10
II	Options market: Basic properties of stock options, Mechanics of options markets, Basic properties of stock Options, Put-Call parity. Introduction to binomial trees: Risk neutral valuation, two-steps binomial tree.	10
III	Elementary stochastic calculus: Markov Property, Martingales, Brownian motion, stochastic integration,	10
IV	Stochastic differential equations and Ito's formula.	08

V	The Black-Scholes-Merton Model: Continuous time model for the stock price, Black-Scholes-Merton equation, pricing puts and calls with the Black-Scholes formula, Implied volatilities; effects of dividends. Hedging with the Greeks	10
Total		48

Text Books:

T1. John C. Hull, “Options Futures and other Derivatives”, Prentice-Hall Inc., 7th Edition, 2009.

T2. John C. Hull, “Fundamentals of Futures and Options Markets” (latest edition) Prentice Hall, 2002

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Reference Books:

R1: Panjer, Harry H (ed), “Financial economics: with applications to investments, insurance and pensions”, The Actuarial Foundation, 1998.

R2: Elton, Edwin J, Martin J Gruber, Stephen J Brown, & William N Goetzmann, “Modern portfolio theory and investment analysis” (6th edition), John Wiley, 2003.

R3: Hull, John C, “Options, futures and other derivatives” (5th edition), Prentice Hall, 2002.

R4: Baxter, Martin & Andrew Rennie, Financial calculus; “An introduction to derivative pricing” Cambridge University Press, 1996.

R5: Hillier F.S. and Lieberman G.J., “Introduction to Operations Research”, McGraw-Hill, 8th Edition, 2006.

R6: Pant J.C., “Introduction to Optimization, Operations Research”, Jain Brothers, 6th Edition, 2004.

R7: Winston W.L., “Operations Research”, Brooks/Cole, 4th Edition, 2004.

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M702	Nonlinear Analysis	8	40	60

Objectives	Fixed point theorems play a very significant role in solving the boundary value problems, eigen value problems, differential equations, random differential equations, integral equations and so on. The objective of this course is to provide some of the classical fixed point theorems and its applications.
Pre-Requisites	Functional Analysis, Topology
Course Outcome	Understand some of the basic fixed point theorems which provides powerful tools in demonstrating the existence of solutions to a large variety of problems in applied mathematics.

Teaching Scheme	25 percent self-study components for students. Surprise test and problem solving during lecture hour by forming group among the students. Home assignments.
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Unit	Topics	Hours
I	Compactness in metric spaces, Measure of noncompactness, Normed spaces, Banach spaces, Hilbert spaces, Uniformly convex, strictly convex and reflexive Banach spaces, Lipschitzian and contraction mapping, Banach's contraction principle.	10
II	Nonexpansive, asymptotically nonexpansive, accretive and quasinonexpansive mappings, fixed point theorems for nonexpansive mappings, nonexpansive operators in Banach spaces satisfying Opial's condition.	10
III	Schauder's fixed point theorem, condensing map, fixed points for condensing maps, the modulus of convexity and normal structure, Sadovskii's fixed point theorem, set-valued mappings	10
IV	Fixed point iteration procedures, the Mann iteration, Lipschitzian and pseudocontractive operators in Hilbert spaces, strongly pseudocontractive operators in Banach spaces, the Ishikawa iteration, stability of fixed point iteration procedures.	10
V	Iterative solution of nonlinear operator equations in arbitrary and smooth Banach spaces, nonlinear m-accretive operator, equations in reflexive Banach spaces.	08
Total		48

Text Books:

T1: An Introduction to Metric spaces and Fixed point theory- M.A. Khamsi and W.A. Kirk, John Wiley and Sons, New York, 2001.

T2: Iterative Approximation to Fixed Points, Lecture Notes in Mathematics- V. Berinde, Springer, 2007

Reference Books:

R1. Fixed point theory, An Introduction-V.I. Istratescu, D. Reidel Publishing Co. 1981

R2. Topics in Metric Fixed Point Theory- K. Goebel and W.A. Kirk, Cambridge University Press 1990

R3. Fixed point theory and best approximation: The KKM-map Principle- S.P. Singh, B. Watson and P. Srivastava, Kulwer Academic Publishers, 1997

Sub. Code	Subject Name	Credit	Int. Mark	Ext. Mark
M703	Research and Publication Ethics	2	20	30

Objectives	This course is based on philosophy of science and ethics, research integrity,
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	publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools will be introduced in this course
Pre-Requisites	Knowledge on basic concept of research and web browsing.
Course Outcome	On successful completion of the course students know the various concepts of research and data collection as well as copy right
Teaching Scheme	Regular classroom lectures with use of chalk and black board. group discussions

Unit	Topics	Hours
I	Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: Definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification and Plagiarism (FFP), Redundant publications: Duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.	10
II	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 contributor ship, Identification of publication misconduct, complaints and appeals, predatory publishers and journals.	10
III	Group Discussions: Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: Examples and fraud from India and abroad Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.	10
IV	Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU. Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: Examples and fraud from India and abroad B. Software tools. Use of plagiarism software like Turnitin, Urkund and other open source software tools.	10
V	Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. A. Databases. Indexing databases, Citation databases: Web of Science, Scopus, etc. B. Research Metrics (3 hrs.): Impact Factor of journal as per Journal Citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g-index, i10 index, altmetrics	8
Total		48

References:

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. Resnik, D.B. (2011). What is ethics in research and why is it important. National Institute of Environmental Health Science, 1-10.
<https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
5. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489 (7415) 179-179.

<https://doi.org/10.1038/489179a>

6. 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.

Detail Syllabus

Sub. Code	Subject Name	Credit	Mark
M704	Literature Review Related to Proposed Topic	6	100

Objectives	The objective of the course is to teach the scholar how to perform i. Scientific research review. ii. Book review
Pre-Requisites	NA
Course Outcome	On successful completion of the course students know the various concepts of research and data collection as well as copy right
Teaching Scheme	

This paper consists of two parts:

In part 1. Provide foundation of knowledge on topic. The purpose of a literature review is to gain an understanding of the existing research relevant to a particular topic or area of study, and to present the knowledge in the form of a written report. Identify gaps in research, conflicts in previous studies.

Part-II: Students are required to undertake an extensive books review in mathematics, Real Analysis, Numerical Analysis, Topology, ODE, PDE, Algebra, Probability Theory, Stochastic Processes, Mathematical finance.

Detail Syllabus

Sub. Code	Subject Name	Credit	Mark
M705	Preparation of Research Proposal/Synopsis	4	50

Objectives	The objective of the course is to teach the scholar how to prepare synopsis for PhD registration
Pre-Requisites	NA
Course Outcome	Students are able to write a proposal
Teaching Scheme	

Detail syllabus:

In this paper students are required to acquire skill to develop a meaningful synopsis for PhD registration and competitive research project proposal.