ಬೆಂಗಳೂರು
ನಗರ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

BENGALURU
CITY UNIVERSITY

Office of the Registrar, Central College Campus, Dr. B.R. Ambedkar Veedhi, Bengaluru – 560 001.
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No.BCU/Ph.D-Syllabus 96 /2025-26 Date. 15.04.2025
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NOTIFICATION

Sub: Mathematics Ph.D Course Work Syllabus of Bengaluru City University

Ref: 1. The recommendations of the Board of Studies in Mathematics (PG)
2. Approval of the Vice-Chancellor dated.09.04.2025

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In pursuance to the recommendations of the Board of Studies in Mathematics (PG) and pending approval of the Academic Council, the Syllabus for Mathematics Ph.D Course Work of Bengaluru City University with is hereby notified for information of the concerned. Effective from the academic year 2025-26

The copy of the Syllabus is notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

To,

1. The Dean, Faculty of Science, BCU.
2. The Chairman & Members of BOS in Mathematics(PG), BCU.
3. The Principals of the concerned affiliated Colleges of BCU – through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file.

Bengaluru City University

Department of Mathematics,

Syllabus for Ph D Course Work in Mathematics

Paper I: Research Methodology

UNIT I: Research Methodology

Introduction to research methodology, Meaning, Objectives, Types, Significance of research, Identification, Selection of research problem, Formulation of research objectives, Extensive research survey, Research Design, Extensive research survey, Research Design, Quantitative and qualitative methodology, Criterion of good research. **(12 hours)**

UNIT II: Professional Writings

Professional Writing: Unit of vertical and horizontal spacing, separation, marks, punctuation marks, non-alphabetical mathematical symbols, formula cosmetics, Principles on elegance in writing- elegance, facilitators and detractors of elegance. **(12 hours)**

UNIT III: Essential Tools

Application of computer packages for mathematics, graph plotting softwares, Latex-like and Latex beamer-like packages for presentation of scientific reports, research papers, thesis and power point presentation. **(12 hours)**

UNIT IV: Essential concepts in Python Programming

Fundamentals, variables, conditional statements, looping structures, functions, Introduction to R, Usage of different packages, ANOVA, MANOVA, regression analysis, introduction to GAP. **(12 hours)**

REFERENCES:

1. P. Davis and R. Hersh, The Mathematical Experience, Penguin 1981.
2. H. Rabinowitz and S. Vogel, The Manual of Scientific Style, Academic Press 2009.
3. C. R. Kothari, Research Methodology, New Age International Publication, 2004
4. L. Lamport, Latex, Addison Wesley Publishing Company,1994.
5. L. Radhakrishna, Write Mathematics Right, Norasa, New Delhi 2013.
6. L.V. Redman and A.V.H. Mory, The Romance of Research, 1923.
7. https://www.python.org

Paper II: Cognate subject: Advanced Algebra and Applied Analysis

Unit I: Convexity and Matrices

Convex sets, convex functions, classical inequalities, convex functions and matrix inequalities, circulant matrices, Toeplitz matrices, non-negative matrices, positive definite matrices, norms for vectors and matrices. **(12 hours)**

Unit II: Characteristic roots and Characteristic vectors

Bounds for characteristic roots and vectors, interlacing, regions containing characteristic roots of general matrix, characteristic roots of special types of matrices, the spread of a matrix, the field of values of a matrix, perturbation theorems, Hermitian and symmetric matrices. **(12 hours)**

Unit III: Formulation of convergence of Fourier series

The (C,1) summability of Fourier series, L^2 theory of Fourier series, Orthonormal expansion in $L^2[a,b]$. **(12 hours)**

Unit IV: Advanced Partial Differential Equations

Existence and uniqueness of solution of linear parabolic, hyperbolic, and elliptic equations, Fundamental solutions, weak solutions, existence of weak solutions, maximum principles. **(12 hours)**

REFERENCES:

1. R A Horn and C R Johnson, Matrix analysis, Cambridge University Press, 1985.
2. M Marcus and H Minc, Survey on matrix theory and matrix inequalities, Allyn and Bacon, Inc., Boston, 1964.
3. Tyn Myint-U, L. Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkhauser, Boston, 2007.
4. L. C. Evans, Partial Differential Equations, AMS Publications, Rhode Island, 1998.

Paper III: Field of Specialization:
(A) Advanced Graph Theory

Unit I: Distance in Graphs

Centers: The center and eccentricity, self-centered graphs, the median, central paths, other generalized centers. Extremal distance problems: Radius, small diameter, diameter, long paths and long cycles. Convexity: closure invariants, metrics on graphs, geodetic graphs, distance–hereditary graphs. Symmetry: Groups, symmetric graphs, distance symmetry. Distance sequences: The eccentric sequence, distance sequences, distance distribution, path sequences, other sequences, related algorithms. **(12 hours)**

Unit II: Spectra of Graphs

Spectrum of a graph: Matrices associated with a graph, characteristic polynomial, spectrum of standard graphs, decomposition, automorphisms, algebraic connectivity, cospectrality. Eigenvalues and eigenvectors: Adjacency eigenvalues, distance eigenvalues, Laplacian eigenvalues and their corresponding eigenvectors, energy. The Grone-Merris conjecture. **(12 hours)**

Unit III: Algebraic Graph Theory

Permutation groups, counting, asymmetric graphs, orbits on pairs, primitivity and connectivity, transitive graphs, arc transitive graphs, generalized polygons and Moore graphs. **(12 hours)**

Unit IV: Distance regular graphs

Parameters, eigenvalues, eigenspaces, feasibility parameter sets, imprimitivity and Q-polynomials, substructures, representation of distance regular graphs (DRGs), classification of known DRGs, Strongly Regular Graphs (SRGs), Directed Strongly Regular Graphs (DSRGs), Graphs of Coxeter and lie type, codes and geometries. **(12 hours)**

REFERENCES:

1. F. Buckley and F. Haraary, Distance in graphs, Adddison-Wesley Pub. Co., 1990.
2. A.E. Brouwer and W. H. Heamers, Spectra of Graphs, Springer, 2011.
3. C. Godsil and G. Royle, Algebraic Graph Theory, Springer, 2001.
4. A.E. Brouwer, A. M. Cohen and A. Nuemaier, Distance regular graphs, Springer, 1989.

Paper III: Field of Specialization:
(B) Advanced Fluid Mechanics

Unit I: Balanced Fundamental laws

Conservation of mass, conservation of linear momentum, Conservation of energy, Motion of non-viscous fluid: - Stress tensor, Equation of motion for non-viscous fluid – Euler's equation: Cartesian and cylindrical coordinates, Bernoulli's equation, and examples. Motion of viscous fluid: - Stress tensors – Navier-Stokes equation: Cartesian and cylindrical coordinates. **(12 hours)**

Unit II: Exact Solutions and their stability

Simple exact solutions of Navier-Stokes equation: Plane Poiseuille flow, Hagen-Poiseuille flow Plane Couette flow. Stability analysis-definitions, perturbations, application of Squire's theorem; Normal mode analysis. Derivation of Reynolds-Orr equation, Orr-Sommerfeld equation. **(12 hours)**

Unit III: Boundary layer flows

Drag and lift, Prandtl's boundary layer theory, momentum and thermal boundary layer equations, structures of boundary layer equations, Karman's momentum integral equation. Flow parallel to a semi-infinite flat plate, Karman-Pohlhausen's method, Karman's momentum theorem, Definitions: Prandtl number, Euler's number, Froude number, Weber number, Mach number. **(12 hours)**

Unit IV: Exact and numerical solutions of boundary layer problems

Boundary layer flow due to stretching/shrinking of the sheet: linear and nonlinear stretching; Boundary layer along a flat plate, flow over a wedge. Asymptotic solutions of the boundary layer equations; Shooting methods, finite difference methods, Chebyshev collocation method, Galerkin method, Rayleigh-Ritz method. **(12 hours)**

REFERENCES:

1. S. W. Yuan, Foundations of fluid mechanics, 1967, Dover Publications, New York.
2. G. K. Batchelor, Introduction to fluid dynamics, 2005, First Indian Edition, CUP, Cambridge.
3. H. L. Evans, Laminar boundary layer theory, 1968, Addison-Wesley Publishing Company, London.
4. R. L. Burden and J. D. Faires, Numerical Analysis, 1978, 9th Edition, Brooks/Cole Cengage Learning.
5. J. P. Boyd, Chebyshev and Fourier Spectral Methods, 2000, 2nd Edition, DOVER Publications, New York.

Paper IV: Research and Publication Ethics

Unit I: Philosophy of Research

Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and reactions. **(4 hours)**

UNIT II: Scientific Conduct

Ethics with respect to Science and research. Intellectual honesty and research integrity, scientific misconducts: falsification fabrication and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing.Selective reporting and misinterpretation of data. **(6 hours)**

UNIT III: Publication of Ethics

Definition, introduction and importance. Best practices/standards setting initiatives and guidelines, Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa types. Violation of publication ethics, authorship and contributorship, identification of publication misconduct, complaints and appeals. Predatory publishers and journals. **(8 hours)**

UNIT IV: Practice-Open Access Publishing

Open access publications and initiatives. Journal finder/journal suggestion tools viz. Elsevier Journal finder, Springer Journal suggester, etc. **(4 hours)**

UNIT V: Publication misconduct

Group discussions- subject specific ethical issues, FFP, Authorship, Conflicts of interest, complaints and appeals: examples and frauds from India and abroad. **Software tools** – Use of plagiarism software by Open Source Software tools, grammar/spellcheck tools. **Databases** – Indenting databases. citation databases: Web Of Science , Scopus, UGC-CARE and other abbreviations, Mathematics Subject Classification, Mathematical Reviews, Math SciNet, ORCID, other E-resources. **Research Metrics** – impact factor of journal as per Journal Citation Report, Copyrights, ISSN, ISBN, Cite Score. Metrics: h-index, g-index, i10 index, Alt metrics. **(8 hours)**

REFERENCES:

1. Bird, A. (2006). Philosophy of science, Routledge.
2. Mac Intyre, Alasdair (1967) A Short History of Ethics, London.
3. Chaddah P., (2018) Ethics in Competitive Research: Do not get Scopped: Do not get plagiarized, ISBN:978-9387480865.
4. 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 Academic Press.
5. Resnik,D.B.(2011).What is ethics in research & why is it important. National Institute of Environmental Health Scienced,1-10.Retrived form. http://www.nichs.nih.gov/researche/resources/bioethics.hatis.index.cfm
6. Beall, J.(2012).Predatory publishers are corrupting open access,Nature,489(7415),179-179.http://doi.org/10.1038/48919a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019).ISBN 978-81-99482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf