GUIDELINES, COURSE STRUCTURE AND SYLLABUS

FOR

Ph.D. COURSE WORK

Department of Mathematics

Faculty of Engineering & Technology

Veer Bahadur Singh Purvanchal University, Jaunpur, U.P., INDIA

(Dr. Mukesh Kumar)	(Dr. Raj Kumar)	(Dr. Uday Raj Prajapati)
External Expert	BOS Convener	BOS member

Guidelines and Syllabus of Ph. D. Course Work
(in partial fulfillment for the award of the degree of Ph. D.)

1. Every student admitted to the Department for Ph.D. programme shall be required to pass the one semester 'Ph.D. Course Work'.
2. A candidate admitted to Ph.D. programme shall be required to complete the Ph.D. Course Work within first two semesters.
3. Candidate has to pass the course work examination only in two attempts failing which his/ her Ph. D. registration shall be cancelled. No provision is made for supplementary examination.
4. There will be one core paper, two open elective papers and one end semester presentation on a topic assigned by his/her research supervisor to communication skills. Each paper and end semester presentation will be of 150 marks.
5. The end semester presentation will be conducted by an examination board comprising the concerned research supervisor, Head of department and Head/Dean of the institute/faculty. The research scholar is required to give end semester presentation in the presence of other students and faculty members.
6. The minimum marks to pass each paper will be 50% and 55% in aggregate to pass the coursework.
7. The papers will be evaluated by the respective course instructor/the concerned faculty member.
8. A candidate will be eligible for appearing in the examination, if he/she fulfills the minimum attendance requirement as per the existing University rules, submission of all fees (dues) as well as submission of examination form within the stipulated time.
9. The guidelines and syllabus of the Ph.D. coursework may be framed and modified by board of studies (BOS) of the Department of Mathematics time to time as per requirement.
10. Thesis of research scholar will be forwarded from the department after clearing minimum IPR standards and norms from IPR cell of the VBS Purvanchal University, Jaunpur.

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EVALUATION SCHEME

In view of office order 1216/academic/2019 dated 21/05/2019

For Ph.D. (Doctor of Philosophy) course work

As per the office order Ph.D. course work will be finished in following three parts:

SUBJECT CODE	Type of Exam.	SUBJECT	Marks
CW-101	**Written examination**	**Research Methodology**	**50**
CW-102	**Practical Exam.**	**Computer Applications**	**50**
CW -103	**Viva voce and Internal Assessment**	**Research Ethics**	**50**

Research supervisor will provide marks to academic section to produce marks sheet of research scholar.

MAPCW-101: Course work

Research Methodology

Review of Literature, Identification of the problem, Searching techniques for research papers, Analysis and discussions, Conclusion with scope for future work, Project Reports preparation, Being acquainted with review of published articles (Mathematical Reviews, SCI journals, SCOPUS, The Zentralblatt MATH, etc.), and books in the field of research work, Familiarity with AMS Subject Classification, Abbreviations of Journals, Impact factor of a journal and h and i-10 index.

Learning of certain relevant software (s) like MAPLE/MATLAB/MATHEMATICA, etc. Familiarity with Latex: Different versions of latex typing , page settings and layouts, Tables and line diagrams, Preparation of survey articles/ regular articles, thesis/books and poster writing, import of graphics, equations writing in different environments, presentation by beamer and learning of different packages of latex, bibliography styles.

Technical Report and Thesis Writing using LaTeX: Research Proposal, Synopsis Writing, Project Proposal for Funding, Thesis Writing.

References:

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1. C.R. Kothari, Research methodology Methods and Techniques, 4th Edition, New Age International (P) Ltd. Publisher, 2014.
2. Leslie Lamport, LaTeX, A Document Preparation System, 2nd Edition, Addison-Wesley Professional Publisher, July, 1994.
3. David R. Wilkins, Getting Started with LaTeX, 2nd Edition, 1995
4. Latex for beginners http://www.docs.is.ed.ac.uk/skills/documents/3722/3722-2014.pdf

Computer Applications

In this course, a student is expected to carry-out a project in each of the following Units. Outcome of each project should be assessed through demonstration and presentation of the work-done. In Units 3 and 4, a student is expected to gain working experience of at-least one computer language, package or tool.

Unit 1: Documentation and Presentation Project using LaTeX

Introductory notions, Handling errors, Formatting text and mathematics, Mathematical formula, LATEX programming, Bibliographies and indices, Producing and including graphics in LATEX file, Floating bodies, Producing slides with LATEX, Postscript fonts, LATEX and other markup languages

Unit 2: Project using Spreadsheet and Database Management System

MS-Excel, MS - Access, Creating Database and Tables, Forms, Entering and editing data, Finding, sorting and displaying data, Printing reports, Forms, Letters and Labels.

Unit 3: Programming Project Using a General Programming language
Maple/Mathematica or other contemporary programming language.

Unit 4: Computer Science Related Programming Project Using a Contemporary Tool/Package
MATLAB for different types of plots, Corel draw and Other for suitable purpose.

References:

1. Leslie Lamport, LaTeX, A Document Preparation System, 2nd Edition, Addison-Wesley Professional Publisher, July, 1994.
2. Leslie Lamport, LaTeX, A Document Preparation System, 2nd Edition, Addison-Wesley Professional Publisher, July, 1994.
3. David R. Wilkins, Getting Started with LaTeX, 2nd Edition, 1995
4. Latex for beginners http://www.docs.is.ed.ac.uk/skills/documents/3722/3722-2014.pdf
5. link for Wikibooks https://en.wikibooks.org/wiki/LaTeX
6. Latex tutorials https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

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Research Ethics

Unit 1: Introduction to Academic Ethics

Ethics & Education; Theories in Ethics; Ethics & Quality Education

Unit 2 Research Technology Ethics

Technology Developments, Impact of Technology on Society, Technological Hazards, Impact on Environment, Ethical Issues in Data Sharing; Data Privacy;

Unit 3 Research & Publications Ethics

Research Ethics, Falsification & Fabrication of Data, Publication Ethics, Research citations, Ethics in Reproduction of Published material, Plagiarism;

Unit 4 Scientometrics and IPR

Biblio-Metrics: Publication Quality, Quantification of Publications, Citation, Impact Factor, H & other indices, Intellectual Property & Rights

References:

1. Gregory, Ethics in Research, 1st Edition, Continuum, Bloomsbury Publishing Plc, 2003.
2. Paul Oliver, The Student's Guide to Research Ethics, 2nd Edition, Open University Press, 2003.

Elective Papers

MAOP-1: VISCOUS FLOW IN POROUS MEDIA L-3, T-1
Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

Review of basic concepts in fluid mechanics, Principles of conservations of mass, momentum (linear and angular) and energy and their significance, Stress and rate of strain, Tensors, Newtonian and non-Newtonian fluids, Constitutive equations, Navier-Stokes equations of motion, Boundary conditions in fluid mechanics, Concept of dynamical similarity and dimensionless numbers and their significance in the fluid dynamics, Some exact solutions of Navier-Stokes equations, Stokes flow, Boundary layer concept.

Mechanics of fluid flow through porous medium: Porosity and permeability, seepage velocity, effective viscosity, Darcy's law, Brinkman's equation.

Reference Books:

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1. J. Happel and H. Brenner, Low Reynolds Number Hydrodynamics, Kluwer Academic Publishers Group, Dordrecht, The Netherlands, 1983
2. Z. U. A. Warsi, Fluid Dynamics, CRC Press, 2005.
3. D. A. Nield and A. Bejan, Convection in Porous Media, Springer-Verlag

MAOP-2 :Lie Groups, Lie Algebras and Similarity Transformations

L-3, T-1

Inter. Assessment 30 marks Sessional test 20 marks

Semester Exam. 100 marks Max. Marks 150

Lie Groups and Their Lie Algebras

Definitions and Examples, Homomorphisms, Lie Subgroups, Covering Group of a Lie Group, Covering Homomorphism, Simply Connected Lie Groups, Exponential Map and Its Properties, Exponential Maps for GLn(C) and its Consequences in Determination of Subgroups of GLn(C), Continuous Homomorphisms, Closed Subgroups, The Adjoint Representation, Homogeneous Manifolds, Examples of Homogeneous Manifolds, Connectedness of classical Lie Groups.

Lie Algebras

Solvable and Nilpotent Lie Algebras, Theorems of Lie and Engel, Killing Form, Semisimple Lie Algebras, Compact Lie Algebras, Structure Theory of Complex Semi simple Lie Algebras, Cartan Sub-algebra, Root Space Decomposition, Real Forms, Compact Real Form. Examples, The Classical Complex Lie Algebras, Cartan Decomposition.

Similarity Transformations Method for Differential Equations

Methods of integration of ordinary and partial differential equations based on invariance under continuous (Lie) groups of transformations. To express a solution in terms of quadrature in the case of ordinary differential equations of first order and a reduction in order for higher order equations. Reduction of partial differential equations at least a reduction in the number of independent variables and in favorable cases a reduction to ordinary differential equations with special solutions or quadrature. Order Reduction of ordinary differential equations by using Lie-group theory and the invariance of ordinary differential equations under transformations. Introduction of continuous groups of transformations of ordinary differential equations, based on the infinitesimal properties of the group. Derivation: a first-order differential equation with the knowledge of a group leads immediately to quadrature, and for a higher order equation (or system) to a reduction in order.

Reference Books:

1. Frank W. Warner : Foundations of Differential Manifolds and Lie Groups
2. Sigurdur Helgason : Differential Geometry, Lie Groups and Symmetric Spaces
3. James E. Humphreys: Introduction to Lie Algebras and Representation Theory
4. P.J. Olver, Applications of Lie Groups to Di_erential Equations. Springer-Verlag, New York (1993).

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5. G.W. Bluman, J.D. Cole, Similarity Methods for Differential Equations, Applied Mathematical Sciences, Springer-Verlag, New York (1974).

MAOP-3: Partial Differential Equations

L-3, T-1

Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

Initial and Boundary Value Problems, Well-posedness, First Order PDEs, The Method of Characteristics, Shocks and Traffic Dynamics, Classiffication of Second Order PDEs. The Heat Equation, Existence and Uniqueness of Solutions, Fundamental Solutions and Green's Function,

The Laplace/Poisson Equation, Existence and Uniqueness of Solutions, Fundamental Solutions and Green's Function, Harmonic Functions, Mean Value Theorem, Maximum Principle, Smoothness of Solutions, Liouville's Theorem, Formulae for Solutions of Drichlet and Neumann Problems.

The Wave Equation, Type of Waves, Uniqueness of Solutions, D'Alembert's Formula, Non-linear Partial Differential Equations. Conversion to Linear Forms. Travelling Waves. Burgers Equation. Dimensional Analysis and Similarity. Nonlinear Diffusion and Dispersion. KdV, Nonlinear Schrodinger and Sine-Gordon Equations. Backlund Transformations. Inverse Scattering Method

Reference Books:

1. L.C. Evans, Partial Differential Equations, AMS
2. I.N. Sneddon, Elements of Partial Differential Equation, McGraw-Hill
3. D. Mitrea, Distributions, Partial Differential Equations and Harmonic Analysis, Springer
4. P.J. Olver, Introduction to Partial Differential Equations, Springer
5. G.B. Folland, Introduction to Partial Differential Equations, Princeton University Press
6. Q. Han, A Basic Course in Partial Differential Equations, AMS
7. P. Prasad & R. Ravirandran, Partial Differential Equations, New Age International

MAOP-4 : Fuzzy Theory and Applications

L-3, T-1
Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

Fuzzy sets, Types of Fuzzy sets; operation on Fuzzy sets, Fuzzy measures, Measures of fuzziness. Fuzzy relations, Properties of Mini-Max compositions, Fuzzy relation equations and its role.

Fuzzy graphs, Fuzzy sets and possibility theory, Fuzzy logics, Fuzziness of fuzzy sets, Fuzzy sets and expert systems, Uncertainty modeling in expert systems, Fuzzy rule based modeling, Fuzzy rule systems for exact physical system described by partial differential equations Fuzzy decisions, Fuzzy linear programming, Fuzzy database, Fuzzy information retrieval, Fuzzy theory and weather classifications, Water demand forecasting Soil water movement and applications in environmental science, Medical diagnosis, Financial markets, Uncertainty in Business management, Psychology, Foods and nutrition with case studies.

Reference Books:

1. Fuzzy sets and fuzzy logic, theory and applications – George J. Klir, Yuan Prentice Hall 2006.
2. Analysis and management of uncertainty: Theory and applications: Ayyub, B. M., L.N. Kanal, North Holland, Newyork 1992.
3. Fuzzy data Analysis : Bandler, W. and W. Nather, Kluwer 1996.

MAOP-5: Numerical Methods L-3, T-1

Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

Introduction to Numerical methods, Initial and Boundary value problems, Numerical solution of ODE, Picard's method, Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta method

Introduction of PDE, Classification of PDE: parabolic, elliptic and hyperbolic. Boundary and initial conditions, Taylor series expansion, analysis of truncation error, Finite difference method: FD, BD & CD, Higher order approximation, Order of Approximation, Polynomial fitting, One-sided approximation.

Parabolic equations in 2D, Explicit & Crank-Nicolson method, Alternating direction Implicit method (ADI), Elliptic equations, Solution of Poisson equation with Example, Successive over Relaxation (SOR) method, Solutions of Elliptic equations by using ADI method.

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Hyperbolic equations, solutions using Explicit method, Stability analysis of Explicit and Implicit schemes, Examples, Characteristics of PDE, Solutions of Hyperbolic equations by using methods of Characteristics, Hyperbolic equation of first order, Stability analysis.

REFERENCE BOOKS:

1. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th Edition, Wesley.
2. Smith, G. D., "Numerical Solution of Partial Differential Equations: Finite Difference Methods", Third Edition Clarendon press Oxford.
3. Chapra, S. C. & Canale, R. P.," Numerical Methods for Engineers "6th Edition, Mc Graw Hill Publication.

MAOP-6: Differential Geometry L-3, T-1

Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

UNIT I: Differential Geometry I

Curves in space R^3, parameterized curves, regular curves, helices, arc length, reparametrization (by arc length), tangent, principal normal, binormal, osculating plane, normal plane, rectifying plane, curvature and torsion of smooth curves, Frenet-Serret formulae, Frenet approximation of a space curve.

Osculating circle, osculating sphere, spherical indicatrices, involutes and evolutes, intrinsic equations of space curves, isometries of R^3, fundamental theorem of space curves, surfaces in R^3, regular surfaces, co-ordinate neighborhoods, parameterized surfaces, change of parameters, level sets of smooth functions on R^3, surfaces of revolution, tangent vectors, tangent plane, differential of a map.
Normal fields and orientability of surfaces, angle between two intersecting curves on a surface, Gauss map and its properties, Weingarten map, second and third fundamental forms, classification of points on a surface.
Curvature of curves on surfaces, normal curvature, Meusnier theorem, principal curvatures, geometric interpretation of principal curvatures, Euler theorem, mean curvature, lines of curvature, umbilical points, minimal surfaces, definition and examples, Gaussian curvature, intrinsic formulae for the Gaussian curvature, isometries of surfaces, Gauss Theorem Egregium (statement only).

Christoffel symbols, Gauss formulae, Weingarten formulae, Gauss equations, Codazzi-Mainardi equations, curvature tensor, geodesics, geodesics on a surface of evolution, geodesic curvature of a curve, Gauss-Bonnet Theorem (statement only).

Unit II: DI FFERENI IAL GEOMETRY II

n-dimensional real vector space, contravariant vectors, dual vector space, covariant vectors, tensor product, second order tensors, tensors of type (r, s), symmetry and skew symmetry of tensors, fundamental algebraic operations, quotient law of tensors.

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Topological manifolds, compatible charts, smooth manifolds, examples, smooth maps and diffeomorphisms, definition of a Lie group, examples.

Tangent and cotangent spaces to a manifold, derivative of a smooth map, immersions and submersions, submanifolds, vector fields, algebra of vector fields, φ-related vector fields, left and right invariant vector fields on Lie groups.

Integral curves of smooth vector fields, complete vector fields, flow of a vector field, distributions, tensor fields on manifolds, r-forms, exterior product, exterior differentiation, pull-back differential forms.

Affine connections (covariant differentiation) on a smooth manifold, torsion and curvature tensors of an affine connection, identities satisfied by curvature tensor.

REFERENCE BOOKS

1. U. C. De, A. A. Sheikh; Differential Geometry of Manifolds, Narosa Publishing House, 2007.
2. Kobayashi and Nomizu, Foundations of Differential geometry, Vol-II, Interscience Publishers, 1963.

MAOP-7: RIEMANNIAN GEOMETRY L-3, T-1

Inter. Assessment 30 marks Sessional test 20 marks
Semester Exam. 100 marks Max. Marks 150

Riemannian metrics, Riemannian manifolds, examples, Levi-Civita connection, fundamental theorem of Riemannian geometry, Curvature tensors- Riemannian curvature tensor, sectional curvature, Schur's Theorem, Ricci curvature, scalar curvature, Einstein manifolds.

Gradient vector fields, divergence of a vector field, Covariant derivative along a curve, parallel transport, length of a curve. Distance function, geodesics, Exponential map,

Jacobi fields, Gauss Lemma, complete Riemannian manifolds, Hopf –Rinow Theorem, The theorem of Hadamard, Riemannian immersions, second fundamental form, Gauss equation, Model spaces of constant curvature.

Lie derivative, Lie derivatives of scalars, vectors, tensors and linear connections, commutation formula for Lie differential operator and covariant differential operator.
Motion, Affine motion, projective motion in a Riemannian space, curvature collineation, conformal and homothetic transformations.

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Books Recommended:

1. D. Somasundaram, Differential Geometry, A First Course, Narosa Publishing House, New Delhi, 2005.
2. Kobayashi and Nomizu; Foundations of Differential geometry, Vol-1, Interscience Publishers, 1963.
3. T. J. Willmore; Riemannian geometry, Oxford Science Publication, 1993.
4. W. M. Boothby; An Introduction to Differentiable Manifolds and Riemannian Geometry, Academic Press, revised, 2003.
5. R. S. Mishra, A course in Tensors with Applications to Riemannian Geometry, Pothishala, Pvt. Ltd., Allahabad, 1965.

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