DETAILED SYLLABUS

Doctor of Philosophy (PhD)

Computer Science and Applications

(EFFECTIVE FROM JULY 2026)

Makhanlal Chaturvedi National University of Journalism and Communication, Bhopal
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Computer Science and Applications

Doctor of Philosophy (PhD)
Course Structure

S.No	Course Name	Credits	Marks			Total Marks
			Theory	Practical	Internal	
1	PHD1: Research Methodology for Computer Applications	4	80		20	100
2	Elective Paper (Choose any 1) PHD2(A): Information and Cyber Security OR PHD2(B): Knowledge Discovery & Computational Intelligence OR PHD2(C): Software Engineering OR PHD2(D): Data Science and Analysis	4	80		20	100
3	PHD3: Literature Review and Development of Draft Synopsis	4	50	30	20	100
4	PHD4 (A): Research and Publication Ethics	2	25	15	10	50
	PHD4 (B): Dissertation	2		40	10	50
	Total	16	235	85	80	400

PHD 1:Research Methodology for Computer Applications

Course Objectives

- To identify and formulate research problems in Computer Science and develop appropriate research objectives, research questions, hypotheses.
- Select and implement optimal research designs by introducing experimental, algorithmic prototypes, empirical, simulation models, and case studies.
- To familiarize with computational research tools like Python, MATLAB, Scilab, OpenModelica, R, Git, and typesetting systems like LaTeX/ Overleaf.
- Apply statistical and data-analysis skills for data preprocessing, sample selection, and descriptive/inferential statistical analysis to validate experimental outputs.
- Develop scientific writing and publication skills including preparation of research papers, technical reports, citations, peer-reviewed publications, and research presentations.

Unit I: Foundations of Research and Problem Identification

- Meaning, objectives, characteristics, and importance of scientific research
- Nature and philosophy of scientific research
- Types of research: Basic, Applied, Quantitative, Qualitative, Mixed Methods, Experimental, and Design Science Research
- Research paradigms and research lifecycle
- Identifying research problems in Computer Science
- Formulating research objectives, research questions, and hypotheses
- Variables, constructs, assumptions, and operational definitions

Unit II: Research Design and Experimental Methodology

- Principles of research design
- Selection of appropriate research methodology
- Experimental, empirical, simulation-based, survey, and case study research
- Prototype development and proof-of-concept research
- Sampling techniques and data collection methods
- Dataset selection and preprocessing
- Experimental planning and documentation
- Reliability, validity, and reproducibility of research

Unit III: Statistical Methods and Data Analysis

- Population, sample, variables, and scales of measurement
- Data collection methods and sampling techniques
- Descriptive statistics: Mean, Median, Mode, Variance, and Standard Deviation
- Probability concepts and probability distributions
- Inferential statistics and hypothesis testing
- p-value, confidence intervals, Type I and Type II errors
- Statistical tests: t-test, Chi-square test, and ANOVA
- Correlation and regression analysis

Unit IV: Experimental Validation and Research Tools

- Experimental design and benchmarking
- Performance evaluation metrics
- Model validation and cross-validation techniques
- Comparative performance analysis and baseline models
- Data visualization and interpretation
- Error analysis, sensitivity analysis, reliability, and validity
- Reproducibility and replicability of research
- **Introduction to Research Tools**
  - ❖ MATLAB/Simulink for mathematical modeling and simulation/ (**GNU Octave**, **Scilab**, **OpenModelica free tool**)
  - ❖ Python (NumPy, Pandas, SciPy, Matplotlib) for data analysis
  - ❖ R for statistical computing
  - ❖ Jupyter Notebook and Google Colab for computational research
  - ❖ SPSS for statistical analysis(**Jamovi**, **JASP**, **PSPP**)
  - ❖ LaTeX/Overleaf for scientific document preparation
  - ❖ Git and GitHub for version control and collaborative research

Unit V: Research Writing, Publication, and Research Management

- Structure of research papers, technical reports, and dissertations
- Scientific writing: Abstract, Introduction, Methodology, Results, Discussion, and Conclusion
- Citation styles and reference management
- Journal and conference publication process
- Peer review process and manuscript revision
- Research impact metrics: Citation count, h-index, i10-index, Journal Impact Factor, Scopus metrics, and Web of Science metrics
- Research data management and documentation
- Research project planning, funding opportunities, and grant proposal basics
- Scientific presentation and communication skills

Recommended Text Books

- Creswell, J. W. & Creswell, J. D. (2023). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (6th Edition). Sage Publications.
- Leedy, P. D. & Ormrod, J. E. (2021). Practical Research: Planning and Design (12th Edition). Pearson.
- Kothari, C. R. & Garg, G. (2019). Research Methodology: Methods and Techniques (4th Edition). New Age International Publishers.
- Montgomery, D. C. (2019). Design and Analysis of Experiments (10th Edition). Wiley.
- Field, A. (2024). Discovering Statistics Using IBM SPSS Statistics (6th Edition). Sage Publications.
- Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer. (Reference for experimental validation and model evaluation.)
- Day, R. A. & Gastel, B. (2024). How to Write and Publish a Scientific Paper (9th Edition). Greenwood.
- Silberschatz, A., Galvin, P. B., & Gagne, G. (Latest Edition). Computer Systems Research Methods (Use relevant CS experimental examples from standard Computer Science texts.)

Text and Reference Books:

- Panneerselvam, R. (2014). Research Methodology. PHI Learning.
- Trochim, W. M., Donnelly, J. P., & Arora, K. (2016). Research Methods: The Essential Knowledge Base (2nd Edition). Cengage Learning.
- Everitt, B. S. &Hothorn, T. (2021). A Handbook of Statistical Analyses Using R (4th Edition). CRC Press.
- NIST/SEMATECH. e-Handbook of Statistical Methods. (Online Reference)

PHD2(A): Information and Cyber Security

UNIT-1

Introduction to Cyber Security: Information Security vs Cyber Security, CIA Triad (Confidentiality, Integrity, Availability), Authentication, Authorization, Accountability, Security Principles and Models, Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques, Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Stream Ciphers, Block Cipher, DES algorithm.

UNIT-2

Asymmetric Key Cryptography, RSA Algorithm, Diffie-Hellman Key Exchange, Digital Signatures, Public Key Infrastructure: Digital Certificates, Internet Security Protocols: Basic Concepts, Secure Socket Layer, SHTTP.

UNIT-3

Hash Functions, MD family, SHA family. DOS, DDOS attacks, Intrusion detection System, Authentication Methods: Passwords, biometrics, Multi-factor authentication,

UNIT-4

Malware Classification, Android Malware Detection approaches, Threat Intelligence, User Behavior Analytics, AI-based Intrusion Detection, Deep Learning for Security: Graph Neural Networks, Federated Learning, Adversarial Machine Learning, Multi-modal AI for Threat Analysis, AI Generated Malware Detection, Fileless Malware Detection,

UNIT-5

LLM-assisted Threat Hunting, Vulnerability Detection using LLMs, AI Security Assistants, Prompt Injection Detection, AI Agent Security, LLM for Security Log Analysis, Cloud Security Models, IoT Architecture, IoT Threats, Lightweight Cryptography, Blockchain Fundamentals, Cloud Forensics, Mobile Forensics, IoT Forensics, Memory Forensics, Deepfake Detection.

Text and Reference Books:

- William Stallings, Network Security Essentials: Applications and Standards, Pearson.
- Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: Private Communication in a Public World, Pearson.
- Ross Anderson, Security Engineering, Wiley.
- Bruce Schneier, Applied Cryptography, Wiley.
- S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Pearson.
- National Institute of Standards and Technology (NIST) Cybersecurity Framework publications.
- Recent research articles from IEEE Transactions on Information Forensics and Security, IEEE Transactions on Dependable and Secure Computing, ACM Computing Surveys, Computers & Security (Elsevier), and Journal of Cybersecurity (Oxford University Press).

PHD2(B):Knowledge Discovery & Computational Intelligence

Course Objectives

- Understand the core concepts of Artificial Intelligence
- Understand the architecture and functioning of Expert Systems
- Understand the principles of Soft Computing and Neural Networks
- Synthesize Supervised Neural Networks and Classical Classifiers
- Implement Unsupervised Learning & Topological Self-Organization
- Understand fuzzy logic and approximate reasoning
- Understand evolutionary computation and Genetic Algorithms
- Explore hybrid intelligent systems and modern AI applications

UNIT-I: Classical AI Foundations, Expert Systems, and KDD Pipelines

AI Paradigms: Definitions of Intelligence, The AI Problems, State-Space representation, Characteristics of AI applications, Current trends in AI, Knowledge Representation issues

Expert Systems: Architecture of Knowledge-Based Systems, Expert System Shells, production systems, mechanisms of Knowledge Acquisition: manual vs. Automated, Case studies: Detailed architectural analysis of MYCIN

Data Infrastructure & Preprocessing: Relational DBMS vs. Data Warehousing schemas (Star, Snowflake), The KDD Process model, Data Mining definitions, usage, and multi-domain applications. Data Preprocessing mechanics: noise filtering, data cleaning and transformations

UNIT-II: Soft Computing & Supervised Learning Paradigms

Soft Computing Introduction, applications, Philosophy of soft computing vs. hard computing,

Neural Network Foundations: Biological inspiration, generalized network architectures, and learning typologies (Hebbian, competitive).

Supervised Learning Architectures: Linear separators, Perceptron learning theorem, convergence proofs, Single-layer vs. Multi-layer Perceptrons (MLP), Backpropagation network

Classical Classifiers: Associative Memory Networks (Hopfield, Bidirectional Associative Memory). Naïve Bayes Theorem, Decision Trees

UNIT-III: Unsupervised Learning & Topological Self-Organization

Competitive & Topological Networks: Kohonen Self-Organizing Maps (SOM) topological mapping math, Counter Propagation Networks (CPN)

Adaptive Resonance Theory: ART architecture, functioning, Stability-plasticity dilemma,

Statistical Clustering: K-Means Clustering, Expectation-Maximization (EM) Algorithm for Gaussian Mixture Models (GMM)

UNIT-IV: Fuzzy Logic & Approximate Reasoning Systems

Fuzzy Set Theory: Crisp sets vs. Fuzzy sets, membership functions, mathematical features of membership functions (support, core, boundary)

Operations & Relations: Complement, intersection, union, algebraic product, and bounded difference. Properties of fuzzy sets, Crisp relations vs. Fuzzy relations, Max-Min and Max-Product composition

Fuzzy Rule-Based Systems: Fuzzy propositions, formation, decomposition, and aggregation of fuzzy rules, fuzzy reasoning engines, Defuzzification methodologies (Centroid, Bisector, Mean of Maximum), Multi-domain applications of fuzzy logic control

UNIT-V: Evolutionary Optimization & Modern Machine Learning Applications

Genetic Algorithms: Fundamental theorem of GA (Schema Theorem), working principles, and optimization spaces. Representation schemas: Binary, value, and permutation encoding, Fitness functions

Genetic Modeling: Genetic operators, crossover, inversion, deletion, and mutation operators.

Introduction to Hybrid Systems (Neuro-Fuzzy, Genetic-Fuzzy, and Neuro-Genetic integration)

Modern Machine Learning Overview, Applications, Large Language Models (LLM), Information Retrieval, Information Extraction, Natural Language Processing and Speech Recognition.

Text and Reference Books:

- Elaine Rich and Kevin Knight "Artificial Intelligence" - Tata McGraw Hill.
- Dan W. Patterson "Introduction to Artificial Intelligence and Expert Systems", Prentice India.
- Nils J. Nilson "Principles of Artificial Intelligence", Narosa Publishing House
- Christopher Bishop, "Pattern Recognition and Machine Learning", Springer

- Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press
- EthemAlpaydin, “Introduction to Machine Learning”, MIT Press
- Tom Mitchell, "Machine Learning", McGraw-Hill
- Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Chapman andHall/CRC Press
- S, Rajasekaran& G.A. VijayalakshmiPai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & Applications, PHI publication.
- S.N. Sivanandam&S.N.Deepa, Principles of Soft Computing, Wiley Publications.
- Manaranjan Pradhan, U Dinesh Kumar “Machine Learning using Python” willey Publication
- Dr. R. Nageswara Rao “Machine Learning in Data Science Using Python” Dream Tech Publications
- Joel Grus, “Data Science From Scratch: First Principles with Python” O'Reilly, Publications
- Aurélien Géron “
- Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems,” O'Reilly, Publications
- Bharti Motwani “Data Analytics using Python” willey Publication
- Ivan Gridin “Practical Deep Reinforcement Learning with Python: Concise Implementation of Algorithms, Simplified Maths, and Effective Use of TensorFlow and PyTorch “ BPB Publications

PHD2(C): Software Engineering

Unit - I

Software development process and models, Secure SDLC, Requirements Engineering, Requirement elicitation and analysis, Requirement Management and requirements validation, Software Requirement Specification(SRS), Project Planning, Scheduling, PERT and CPM. Empirical Measurements, Empirical analysis methods, COCOMO model, Phase wise metrics, Function Points Metrics, Cost Estimation. Component Based Software Development, Autonomous Software Systems, Green Software Engineering, Sustainable Software Development.

Unit – II

Design specification, Unified Modeling languages and techniques, Software Architecture: Functional and Non-Functional, Properties of software Architecture, Software Design with Reuse(Component-based development), Software Design Document(SDD). Event-driven Architecture, Cloud Native Architecture.

Critical software systems design: availability and reliability, safety system, specification and design, fault-tolerance, software Evolution: legacy system, software change and re-engineering, Reverse-Engineering, Software configuration management, Software Risk Management.

User Interface Design: Concepts of UI, Interface Design Model, Internal and External Design, Evaluation, Interaction and Information Display.

Unit - III

Introduction to Coding, Coding Standards and Guideline, Infrastructure as Code.

Introduction of Software Testing, Objectives and process of Software Testing, Different types of Testing, Levels of Testing, like Unit, Integration & System Testing, Black Box, and White Box Testing, Software testing tools: QTP, JUnit, Major, selenium testRigor, Testsigma, Mabl, Cursor AI / GitHub Copilot, etc. Mutation Testing,Differential Testing, Fuzz Testing, Search Based Software Testing, Test case designing Techniques, Test case optimization, Software Testing Metrics. Software Reliability Models: The Rayleigh Model, Exponential Distribution and Software Reliability Growth Models, Software Reliability Allocation Models, Criteria for Model Evaluation.

Unit – IV

Software Quality Management and Models: Modeling Process, Software Quality Assessment Models: Hierarchical Model of Software Quality Assessment.CMM and ISO Model, Software Quality Management, & Software Quality Assurance, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Statistical Quality Assurance, Total Quality Management, Quality Standards and Processes, Quality Certification, Software Quality Metrics, Product Quality Metrics: Defect Density, Customer Problems Metric, Customer Satisfaction Metrics.

Distributed Software System, middleware systems, client/server transaction processing, Distributed computing architectures and paradigms, Service-Oriented Architecture(SOA) and Computing paradigm, service-oriented software development, service provider, service broker, and service client and Quantum Computing.

Unit – V

Generative and Agentic AI for Software Engineering: Prompt Engineering for Software Development, Prompt Security, GenAI in Software Development across all phases, AI Agents for Software Development, GenAI into software Development Workflow, GenAI for Requirements Analysis and Designing: Automated Requirement elicitation, Gen-AI for Designing,AI-assisted Design, AI-assisted Architecture, Consistency checking, and AI-driven architecture-to-code synthesis, AI Driven User Interface, GenAI Models for Code. GenAI-Assisted for Pair Programming, Code Generation & Refactoring: Automating Code Refactoring with AI, Automated program synthesis, multi-file code editing, and intelligent technical-debt refactoring, LLM-based Code Review, Retrieval-Augmented Generation (RAG). GenAI for Verification, Testing & Repair: End-to-End Test Automation Automated test-case generation, Multi-objective Test case Optimization, metamorphic testing, and neural program repair/bug-fixing mechanisms GenAI for Software Debugging and Error Detection, Autonomous Bug Fixing, Database Optimization, Challenges and Opportunities of GenAI in Software Development.

AI-Driven Security for Software Engineering: Software Security, DevSecOps, AIOps, MLOps, Adversarial attacks on code models, data privacy in enterprise training, and provenance tracking.

Text and Reference Books:

- Sommervill, A.I Software Engineering, 5th edition, Addison-Wesley,
- Amorose, B.E, Fundamentals of Computer Security Technology, Prentice Hall 3. Darrel, C.I Developing Distributed and E-Commerce Application, Addison-Wesley,
- Roger S Pressmen, Software Engineering a Practitioner's Approach, McGRAW- HILL
- Normal Fenton and Pleeger, Software Metrics- A Rigiorous and Practical Approach, Internal Thomson Computer Press,
- Yogesh Singh SOFTWARE TESTING, Cambridge University Press
- K K Agrawal & Yogesh Singh, Software Engineering, Paper Back
- Andrew Ng – Machine Learning Yearning.
- Chip Huyen – AI Engineering.
- Russel & Norvig – Artificial Intelligence: A Modern Approach.
- Martin Fowler – Refactoring.
- Jez Humble & David Farley – Continuous Delivery.
- James Phoenix, Mike Taylor Prompt Engineering for Generative AI
- Richard Davies, Rafael Fischer Prompt Engineering in Practice Design, test, and improve AI prompts
- Prasanna Venkatesan Nagarajan Prompt-Driven Development Handbook
- Prem Timsina Building Transformer Models with PyTorch 2.0 r
- Dr. Prabhat Kumar Artificial Intelligence
- Devesh Rajadhyax Building Generative AI for Enterprise
- Jos Alfonso Aguilar-caldern , Generative Ai in Software Engineering, IGI Global
- Saurabh Shrivastava (Author), Kamal Arora (Author), Ashutosh Dubey Generative AI for Software Developers: Future-proof your career with AI-powered development and hands-on skills
- Nicholas Thomas, AI Augmented Engineering: Reimagining the Software Development Lifecycle with Agentic AI
- Dr. Muralidhar Kurni Ramesh Krishnamaneni Dr. Srinivasa K. G. AI-assisted Programming for Web and Machine Learning
- Tom Taulli, AI-Assisted Programming Better Planning, Coding, Testing, and Deployment, O'Reilly

PHD2(D): Data Science and Analysis

UNIT 1: Foundations of Data Science

- Introduction to Data Science
- Data Science Lifecycle
- Types and Sources of Data
- Data Acquisition and Data Collection
- Data Science Process
- Applications of Data Science
- Big Data Concepts and Characteristics
- Data Science vs. Business Intelligence vs. Big Data
- Data Science Ecosystem and Tools
- Ethical Issues in Data Science

UNIT 2: Data Preparation and Visualization

- Python for Data Science
- NumPy and Pandas
- Data Import and Export
- Data Wrangling
- Data Cleaning
- Handling Missing Values and Outliers
- Data Transformation
- Feature Engineering (Introduction)
- Exploratory Data Analysis (EDA)
- Data Visualization using Matplotlib and Seaborn

UNIT 3: Statistical Foundations for Data Science

- Descriptive Statistics
- Probability Fundamentals
- Probability Distributions
- Sampling Techniques
- Statistical Inference
- Hypothesis Testing
- Correlation Analysis
- Linear Regression
- Multiple Regression
- Logistic Regression
- Model Validation

UNIT 4: Machine Learning for Data Science

- Introduction to Machine Learning
- Supervised and Unsupervised Learning
- Data Partitioning

- Decision Trees
- Naïve Bayes
- k-Nearest Neighbour (k-NN)
- Model Evaluation Metrics
- Cross Validation
- Introduction to Clustering
- K-Means and Hierarchical Clustering

UNIT 5: Advanced Data Science Applications

- Linear Algebra Basics
- Matrix Operations
- Singular Value Decomposition (SVD)
- Principal Component Analysis (PCA)
- DBSCAN Clustering
- Introduction to Text Mining
- Natural Language Processing Fundamentals
- Data Science Applications in Research
- Data Science Case Studies
- Mini Project using Open Datasets

Text and Reference Books:

1. Introduction to Data Science – Laura Igual& Santi Seguí, Springer.
2. Python for Data Analysis – O'Reilly Media.
3. Hands-On Machine Learning with Scikit-Learn, Keras& TensorFlow – O'Reilly Media.
4. Data Science for Business – O'Reilly Media.
5. An Introduction to Statistical Learning – Springer.

PHD3:Literature Review and Development of Draft Synopsis

Unit 1: Foundations of Literature Review

- **Objective Formulation:** Meaning, Purpose, and Importance of Literature Review, Types of literature, Defining scope, boundaries, and specific objectives of the literature search.
- **Source Identification:** Navigating IEEE Xplore, ACM Digital Library, Scopus, Google Scholar, Web of Science.
- **Search Strategies:** Boolean operations, keyword matrix formulation, citation chaining (forward/backward**)**
- **Reference Management:** Mastery of tools like Zotero, Mendeley, or BibTeX.
- **Literature Classification:** Distinguishing between conference proceedings, journals (SCI/Scopus indexed), and survey papers.

Unit 2: Critical Analysis and Synthesis

- **Analytical Reading:** Reading research papers efficiently, Critical appraisal of articles, Comparative analysis of existing research Deconstructing papers (Abstract, Architecture, Methodology, Proofs, Results).
- **Taxonomy Development:** Categorizing literature by methodology, datasets, metrics, architecture, algorithmic paradigm, application domain.
- **Gap Identification:** Identifying algorithmic limitations, Spotting computational/ data bottlenecks, scalability issues, architectural flaws.
- **Synthesis Matrix:** Data extraction and synthesis,Constructing comparative tables mapping methodologies, datasets used, and performance metrics.

Unit 3: Components of a Research Synopsis

- **Structural Anatomy:** Title selection, Abstract, Introduction, literature Review, Objectives, Methodology, and Timeline.
- **Title Formulation:** Crafting precise, descriptive, and technically accurate research titles.
- **Introduction & Context:** Setting the background, societal impact, and industrial relevance of the study.
- **Problem Definition:** Formulating a crystal-clear, concise statement of the core computational challenge, converting it into a formal mathematical or logical statement.
- **Research Questions:** Translating gaps into clear, testable research questions, Formulating specific research questions and verifiable technical hypotheses.
- **Scope of work:** Defining structural boundaries, assumptions, and constraints of the proposed work. Explicitly defining what the research will cover and what remains out of scope.
- **Methodology Selection:** Choosing appropriate research paradigms (experimental, theoretical, simulation, or empirical).
- **Validation Frameworks:** Planning benchmarks, baseline models, statistical significance tests (e.g., t-test, ANOVA) or performance indicators.

Unit 4: Introduction to AI Tools

- **Introduction to Generative AI:** Evolution of Artificial Intelligence, Generative AI and Foundation Models , Large Language Models (LLMs), Multimodal AI Models, AI Ecosystem for Research
- **Prompt Engineering** : Fundamentals of Prompt Engineering, Role-based and Persona Prompting, Context-aware Prompting
- **AI-assisted Literature Review**: AI-based Literature Search, Semantic Search, Research Gap Identification, Automatic Summarization, Comparative Literature Analysis
- **AI Tools for Research**: Conversational AI: ChatGPT, Gemini, Microsoft Copilot, Claude , Research Search Engines: Perplexity AI, Elicit, Consensus, Literature Analysis: SciSpace, ResearchRabbit, Connected Papers, AI Notebook and Knowledge Management: NotebookLM, Reference Management with AI: Zotero AI, Mendeley

Unit 5: AI Tools for Research

- **AI-assisted Scientific Writing**: Writing Research Proposals, Drafting Journal and Conference Papers, Thesis and Dissertation Writing, Abstract and Conclusion Generation, Grammar and Style Enhancement, Citation and Reference Assistance, AI-assisted LaTeX and IEEE Formatting
- **AI for Experimental Research**: AI-assisted Code Generation, Algorithm Development, Code Review and Refactoring, Documentation Generation, Debugging and Optimization
- **AI for Data Analysis and Visualization**: AI-assisted Data Cleaning, Exploratory Data Analysis, Statistical Analysis Support, Machine Learning Experiment Design, Data Visualization, Automated Report Generation
- **AI for Research Productivity**: AI Agents for Research Automation, AI-based Project Planning, Research Workflow Automation, AI-assisted Presentation Development
- **Ethics, Governance and Responsible AI**: Responsible AI in Research, AI Hallucinations and Fact Verification, Bias and Fairness in AI Outputs, Academic Integrity and Plagiarism, Copyright and Intellectual Property, Privacy and Confidentiality, AI Disclosure Policies in Scientific Publications

Text and Reference Books:

- Chris Hart "Doing a Literature Review: A Practical Guide" SAGE Publications
- Lawrence A. Machi and Brenda T. McEvoy "The Literature Review: Six Steps to Success"SAGE Publications
- John W. Creswell and J. David Creswell "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" SAGE Publications
- C. R. Kothari and Gaurav Garg "Research Methodology: Methods and Techniques"New Age International Publishers
- Barbara Gastel and Robert A. Day "How to Write and Publish a Scientific Paper" Cambridge University Press

PHD4(A): RESEARCH AND PUBLICATION ETHICS

Theory

Unit 1: Philosophy and Ethics

- Introduction to Philosophy: Definition, Nature and Scope, Concept, Branches
- Ethics: Definition, Moral Philosophy, Nature of Moral Judgements and Reactions

Unit 2: 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,nSalami Slicing
- Selective Reporting and Misrepresentation of Data

Unit 3: Publication Ethics

- Publication Ethics: Definition, Introduction and Importance
- Best Practices/Standards Setting Initiatives and Guidelines: COPE, WAME, etc.,
- Publication Misconduct: Definition, Concept, Types, Problems that Lead to Unethical Behaviour and Vice-versa
- Violation of Publication Ethics, Authorship and Contributorship
- Conflicts of Interests
- Identification of Publication Misconduct, Complaints and Appeals
- Predatory Publishers and Journals

Practice

Unit 4: Open Access Publishing

- Open Access Publications and Initiatives
- SHERPA/ROMEO Online Resources to Check Publisher Copyright & Self-Archiving Policies
- Software Tool/Website (UGC-CARE Website) to Identify Predatory Publications Developed by Savitribai Phule Pune University (SPPU)
- Journal Finder/ Journal Suggestion Tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester etc.

Unit 5: Publication Misconduct

A. Group Discussions

- Subject Specific Ethical Issues, FFP, Authorship
- Conflict of Interests
- 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 Databases and Research Metrics

C. Databases

- Indexing Databases

- Citation Databases: Web of Science, Scopus etc.

D. Research Metrics

- Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
- Metrics: h-index, g-index, i10 index, Altmetrics

Text and Reference Books:

- Bird, A. (2006). Philosophy of Science. Routledge.
- MacIntyre, Alasdair.(1967). A ShortHistory of Ethics. London.
- Chaddah, P. (2018). Ethics in Competitive Research: Do Not Get Scooped, Do Not Get Plagiarised. ISBN: 978-9387480865. Available at https://www.researchgate.net/publication/331470963_Ethics_in_Competitive_Research_Do_not_get_scooped_do_not_get_plagiarized
- National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research (3rd Ed.). National Academies Press. DOI: 10.17226/12192
- Resnik D. B. (2011). What is Ethics in Research & Why is it Important? National Institute of Environmental Health Sciences. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfmBeall, J.(2012). Predatory Publishers are Corrupting Open Access. Nature, 489(7415), 179. https://doi.org/10.1038/489179a
- Indian National Science Academy (INSA). (2019). Ethics in Science Education, Research and Governance. ISBN: 978-81-939482-1-7

PHD4(B): Dissertation

The **Ph.D. Coursework Dissertation in Computer Science** is an assessed research exercise intended to develop research aptitude, technical competence, critical thinking, problem-solving ability, originality of approach, and scientific communication skills.

The dissertation should demonstrate that the scholar can **identify a research problem, conduct a focused literature review, identify a research gap, formulate objectives, select an appropriate methodology, undertake technical/research work, analyse results, and present findings scientifically**.

For coursework, originality need not necessarily represent a major Ph.D.-level breakthrough. A **well-defined improvement, comparative study, implementation, framework, dataset analysis, optimization, or new application** may constitute an appropriate contribution.

1. Suggested Research Objectives

The following objectives may be considered while formulating the dissertation:

I. **Identify the Research Problem**
To identify a relevant problem or research gap and formulate a clear, specific, and researchable problem statement.

II. **Review Literature and Establish the Research Gap**
To critically study existing research and identify limitations, gaps, or opportunities for further investigation.

III. **Design the Research Methodology**
To select appropriate algorithms, models, datasets, tools, technologies, or experimental procedures for addressing the research problem.

IV. **Evaluate the Proposed Approach**
To develop, implement, simulate, analyse, or experimentally evaluate the proposed approach.

V. **Analyse and Report the Findings**
To analyse the results, compare them with existing approaches, identify limitations, and present the findings scientifically.

2. Academic Integrity and Plagiarism Prevention

Academic integrity shall be an essential component of the dissertation.The scholar must:

- Ensure that the work submitted is original.
- Properly cite and reference all sources.
- Acknowledge material obtained or adapted from other researchers.
- Avoid plagiarism, fabrication, falsification, and other forms of academic misconduct.
- Maintain appropriate ethical standards while collecting, processing, and using research data.

The final dissertation shall be subjected to **electronic plagiarism/similarity screening using the software and procedure approved by the University**.The permissible similarity level

and treatment of similarity shall be governed by the **latest applicable University and UGC regulations.** The **Plagiarism/Similarity Report shall be submitted along with the final dissertation**, as required by the University.

3. Research and Submission Requirements

Every scholar shall demonstrate a clearly defined and researchable problem, supported by a focused review of approximately 15–25 relevant research papers, preferably including recent studies, and identify a clear research gap with 3–5 specific research objectives. The dissertation shall include a justified research methodology and meaningful technical/research work beyond a literature review, supported by appropriate results, tables, graphs, metrics, analysis, and comparison with existing approaches, wherever applicable. The work shall clearly present its limitations and scope for future work and comply with applicable standards of academic integrity, ethical research, plagiarism prevention, proper citation, and referencing.

The final submission shall include the **dissertation document, abstract and keywords, references/bibliography, plagiarism/similarity report, appendices wherever required, signed candidate undertaking/declaration, and signed supervisor certificate**, and shall be submitted in accordance with the University's prescribed academic and submission requirements.