School of Computer Applications
Doctor of Philosophy (Ph.D.)

Program Educational Objectives (PEOs)

PEO1. Demonstrate advanced knowledge, critical thinking, and analytical skills in research ethics and scholarly conduct.

PEO2. Establish a strong foundational understanding necessary for conducting original and innovative research in Computer Science.

PEO3. Gain practical expertise in designing and executing research projects within Computer Science and interdisciplinary domains.

PEO4. Contribute to society by leveraging academic expertise, research resources, and technical services for community development.

PEO5. Exhibit a comprehensive understanding of standards in the formulation, execution, and dissemination of scientific research.

Program Outcomes (POs)

PO1. Understand and uphold ethical practices in academic research and scholarly publications.

PO2. Apply research methodologies systematically to develop structured and impactful research outcomes.

PO3. Integrate advanced knowledge of Computer Applications to solve complex, real-world problems through original research.

PO4. Stay abreast with current advancements and research directions in core areas of Computer Science and Applications.

PO5. Demonstrate in-depth knowledge and expertise in specialized areas of Computer Science and Applications.

PO6. Design and conduct high-quality, original research contributing to the academic and professional computing community.

PO7. Communicate research findings effectively through scholarly writing, technical documentation, and professional presentations.

PO8. Utilize analytical tools, software environments, and computational methods for advanced problem-solving and data analysis.

PO9. Collaborate effectively in interdisciplinary research settings and contribute to team-based academic initiatives.

PO10. Pursue lifelong learning in emerging technologies and methodologies

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CURRICULUM STRUCTURE

Program: Doctor of Philosophy (Ph.D.) in Computer Applications
Total Credits: 20
UGC Prescribed Credits: 14 to 16

S. No.	Course Code	Course Name	Periods			Credits
			L	T	P	
1	PHDCA 701	Research Methodology	4	0	0	4
2	PHDCA 702	Applied Graph Theory, Algorithms and Statistical Methods	4	0	0	4
3	PHDCA 703	Research and Publication Ethics	2	0	0	2
4	PHDCA 704	Seminar / Presentation	-	-	0	2
5		Core Course-1	4	0	0	4
6		Core Course-2	4	0	0	4
Total Credits			**18**	**0**	**0**	**20**
Total Contact Hours			**18**			

Note: Core Course-1 and Core Course-2 will be domain specific Computer Applications Courses and will be based on the area of research chosen by the research scholar.

S. No.	Subject Code	Core Course
1	PHDCA 705	Modelling and Simulation
2	PHDCA 706	Cloud Technologies
3	PHDCA 707	Big Data Analytics
4	PHDCA 708	Cryptography
5	PHDCA 709	Machine Learning
6	PHDCA 710	Advanced Software Engineering

List of Core Courses

PROGRAM SYLLABI

Course: RESEARCH METHODOLOGY			Semester: I
Course Code:PHDCA701	LTP	4 0 0	Credits: 4

OBJECTIVE	The purpose of this course is to enable the students understand the fundamentals of research methodology and use them in the research endeavor.		
COURSEOUT COMES	**Upon completion of the course research scholar should be able to:** 1. **Demonstrate an understanding of ethical practices** in academic research and publication, ensuring integrity and compliance with scholarly standards. 2. **Apply systematic research methodologies** to design, analyze, and develop structured and impactful research outcomes in Computer Science. 3. **Integrate domain knowledge** to solve complex problems using current trends and specialized areas such as AI, Big Data, Cloud Computing, and Cryptography. 4. **Analyze and interpret data** using inferential and nonparametric statistical tools, including regression models, classification techniques, and hypothesis testing. 5. **Prepare and present high-quality research reports and theses,** following scientific structure, formatting conventions, referencing standards, and oral presentation techniques.		
COURSEDET AILS	**Unit No.**	**Topic**	**Hours**
	1.	**Introduction:** Scientific investigation, Statistics in scientific enquiry, Research philosophy: Positivism, Realism, Interpretive, Pragmatism, Basic research and applied research, Research design and internal validity, Qualitative Research Strategy: Case Study, Ethnography, Focus Groups, Depth Interview, Projective Techniques, Quantitative Research Strategy: Survey, Experiment, Observation, Content Analysis, The research process, Planning a research project and formulating research questions, Structuring the research proposal, Review of literature, searching data bases, Issue of plagiarism, Case study approach.	**10**
	2.	**Measurement and Scaling:** Theory of measurement, Comparative scaling, Primary scales of measurement, non comparative scaling, Questionnaire design: Questionnaire design process, Focus group discussion, Pre-testing questionnaire, Construct validity and reliability	**10**

	3.	**Sample Design and Data Collection:** Census and sample, Sampling design process and external validity, Classification of sampling techniques: probability and non-probability sampling techniques, Sample size determination, Data collection process, Online data collection, and Interaction content on web	**10**
	4.	**Inferential Statistics and Nonparametric Statistics:** 1-Sample Kolmogorov–Smirnov test, z-test, t-test, and test of significance. It also explores Analysis of Variance (ANOVA), simple linear regression, and multivariate regression. Advanced concepts such as moderation and mediation analysis, classification methods (logistic, binary, and probity models), factor analysis, cluster analysis, multi-dimensional scaling, MANOVA, and structured equation modeling are also introduced. Additionally, nonparametric tests like Chi-square distribution, Wilcoxon rank-sum test, Mann-Whitney test, Kruskal-Wallis test, rank correlation, and goodness-of-fit	**24**
	5.	**Reporting and Thesis Writing:** structure and components of scientific reports, types of reports including technical reports and theses, and the significance of each section. It guides learners through various stages such as preparation steps, layout, language, and organization of a typical report. Instruction is provided on how to use illustrations and tables effectively, how to draw conclusions, and how to make suggestions. The section also covers proper bibliography formatting, referencing, and footnoting styles, along with oral presentation skills, including the use of visual aids to effectively communicate research findings.	**06**
		Total Hours	**60**
TEXTBOOK	1. Saunders; *Research Methods for Business Students;* Pearson Education 2. William M. K. Trochim; *Research Methods*; Bizantra		
REFERENCE BOOK/SUGGESTED READING	3. V. Kumar, International Marketing Research; Prentice Hall of India 4. Hair,Anderson,TathamandBlack;MultivariateDataAnalysis;PearsonEducation 5. Michael,S.Lewis-Beck,Bryman,AlanE.andTim,FutingLiao;TheSageencyclopediaof Social Science Research Methods; Sage Publications 6. Sherri,L.Jackson;ResearchMethods:AModularApproach;ThomsonWadsworth		

Course: APPLIED GRAPH THEORY, ALGORITHMS AND STATISTICAL METHODS			Semester: I
Course Code: PHDCA702	LTP	4 0 0	Credits: 4

OBJECTIVE	The objective of this course is to equip researchers with the foundational and advanced concepts of graph theory, algorithm design, and statistical analysis. It aims to develop the analytical skills necessary to model complex problems, evaluate algorithm efficiency, and perform data-driven decision-making through statistical tests, regression techniques, and simulation models. By the end of the course, students will be capable of applying computational and mathematical techniques to solve real-world problems in a structured and efficient manner.		
COURSE OUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Understand the fundamentals of graph theory and apply graph traversal algorithms like DFS, BFS, and Dijkstra, along with analyzing trees, spanning trees, and minimum spanning trees in various computational problems. 2. Analyze algorithmic complexity using asymptotic notations, solve recurrence relations, and design efficient algorithms using divide-and-conquer and greedy strategies. 3. Apply statistical estimation and hypothesis testing techniques, including Z-tests, T-tests, F-tests, chi-square tests, and ANOVA, to evaluate significance and make informed decisions based on data. 4. Perform regression and correlation analysis, including linear and multiple regression, significance testing, goodness-of-fit measures, and evaluate relationships using Pearson's and Spearman rank correlation. 5. Demonstrate the ability to model real-world systems using simulation techniques, distinguish between simulation and analytical methods, and apply simulation to problems like queuing systems and inventory management.		
COURSE DETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Graph Theory:** Graph & applications of graph, Graph & its properties, representation of Graph, DFS & BFS, Dijkstra algorithm. Tree & its properties, spanning tree, Minimum Spanning Tree	**12**
	2.	**Designing and Analysis of Algorithms:** Asymptotic notations, Complexity of Algorithms, Mathematical Analysis of Non-Recursive and Recursive Algorithms**.** Recurrences and Solution of Recurrence Equations, generating function. Divide and conquer, greedy algorithm.	**12**
	3.	**Statistical Estimation and Testing:** Tests of significant of attributes, Z-test of significance and Coefficient of correlation, Small sample test, T-test, Paired Test, F test of equality of variance, large sample test, Normal test. Non-Parametric Test: **Chi-square** test, ANOVA.	**12**

	4.	**Regression & Correlation Analysis:** Linear Regression: Statistical Inferences in Linear Regression, Multiple Regression, going beyond a single Explanatory Variable, Significance Testing and Goodness of Fit, and working with Qualitative Variables. Pearson's and Spearman Rank Correlation..	**12**
	5.	**Modelling and simulation:** Introduction to Modelling & simulation. System simulation, Why to simulate and when to simulate, Basic nature of simulation, technique of simulation, comparison of simulation and analytical methods, types of system simulation, real time simulation, hybrid simulation, simulation of pure-pursuit problem single-server queuing system and an inventory problem	**12**
		Total Hours	**60**
TEXTBOOK	1. West, D. B. *Introduction to graph theory* (2nd ed.). Pearson Education. 2. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). *Introduction to algorithms* (3rd ed.). MIT Press.		
REFERENCE BOOK/SUGGESTEDREADING	3. Gupta, S. C., & Kapoor, V. K. Fundamentals of mathematical statistics (12th ed.). Sultan Chand & Sons. 4. Draper, N. R., & Smith, H. Applied regression analysis (3rd ed.). John Wiley & Sons. 5. Gordon, G. System simulation (2nd ed.). Pearson Education.		

Course: RESEARCH AND PUBLICATION ETHICS			Semester: I
Course Code: PHDCA 703	**LTP**	**2 0 0**	**Credits:2**

OBJECTIVE	This course, delivered through a blend of theoretical and practical sessions, focuses on the fundamentals of the philosophy of science and ethics, research integrity, and publication ethics. Hands-on sessions are designed to help scholars identify research misconduct and predatory publications. Additionally, the course introduces indexing and citation databases, open access publishing, research metrics such as citations, h-index, and impact factor, as well as tools for detecting plagiarism.		
COURSE OUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Explain the basic concepts of philosophy, ethics, and moral values, and describe the principles of responsible conduct in research. 2. Identify ethical issues in scientific research and explain the correct practices related to authorship, scientific misconduct, and handling complaints. 3. Describe the importance of publication ethics and apply standard guidelines to avoid unethical practices like plagiarism, falsification, and publication in predatory journals. 4. Identify different open access publishing models, tools for journal selection, and licensing options, and explain their appropriate use in research publishing. 5. Prepare research reports and theses using standard formats, referencing styles, and visual aids, and explain the use of research performance metrics.		
COURSEDETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Introduction to philosophy:** definition, nature, and scope; ethics and moral philosophy; research ethics and principles of responsible conduct in research.	**04**
	2.	**Scientific Conduct**: Ethics in science and research, intellectual honesty, scientific misconduct (FFP), redundant publications, authorship and contributorship, handling complaints and appeals.	**04**
	3.	**Publication Ethics:** Introduction and importance of publication ethics; guidelines by COPE, WAME; conflict of interest; types of misconduct; predatory journals and detection tools.	**07**
	4.	**Open Access Publishing :** Open access models and initiatives; SHERPA/RoMEO, Creative Commons; journal suggestion tools (JANE, Elsevier, Springer); plagiarism detection tools (Turnitin, Urkund, etc.).	**04**
	5.	**Research Reporting and Thesis Writing:** Structure and types of research reports; formatting, referencing styles (APA, IEEE, etc.); use of tables, illustrations; thesis writing; oral presentation and visual aids., IPP, Cite Score Metrics: h-index,gindex, i10index, altmetrics	**11**
		Total Hours	**30**

TEXT BOOK	1. Macrina, F. L. *Scientific Integrity: Text and Cases in Responsible Conduct of Research* . ASM Press. 2. Steneck, N. H. *ORI Introduction to the Responsible Conduct of Research*. U.S. Department of Health and Human Services.
REFERENCE BOOK/SUGGESTED READING	3. Indian National Science Academy (INSA). Ethics in Science Education, Research and Governance 4. COPE. (n.d.). Committee on Publication Ethics. Retrieved from https://publicationethics.org 5. Elsevier. (n.d.). Publishing Ethics Resource Kit. Retrieved from https://www.elsevier.com/about/policies/publishing-ethic. 6. UGC. (2019). *UGC Guidelines for Research and Publication Ethics (RPE)*.

Course: SEMINAR /PRÉSENTATION			Semester: I
Course Code: PHDCA704	LTP	0 0 0	Credits: 2

OBJECTIVE	The objective of this seminar is to provide doctoral students with a platform to critically engage with current research trends, present their scholarly work, and develop advanced communication skills. Through structured presentations and academic discussions, the seminar aims to foster interdisciplinary dialogue, enhance research methodologies, and cultivate a deeper understanding of subject-specific knowledge relevant to their doctoral studies.

Course: MODELLING AND SIMULATION			Semester: I
Course Code: PHDCA705	LTP	4 0 0	Credits: 4

OBJECTIVE	The goal is to introduce students to basic methods and tools for modeling and simulation of continuous, discrete and combined systems in time and space dimensions		
COURSE OUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Learn how to create and use models to represent real-world systems. 2. Predict and study how systems behave under different conditions. 3. Work with software to simulate and test different scenarios. 4. Use equations and algorithms to model complex processes. 5. Use simulations to solve problems and improve decision-making in various fields.		
COURSED ETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Modeling:** Definition of System, system concepts, types of system, continuous and discrete systems, modelling process, verification and validation. Simulation: Introduction, classification of simulation models, advantages and disadvantages of simulation	**12**
	2.	**Discrete system simulation:** Monte Carlo method, Random Number Generation: Congruence generators, long period generators, uniformity and independence testing. Random Variate Generation: Location, scale and shape parameters, discrete and continuous probability distributions; Inverse transformation method	**12**
	3.	**Queuing Theory:** Introduction, notation and assumption, Little's theorem, queuing model with poison input, exponential service and arbitrary service times, simulation of queuing system, simulation of single-server queue, Simulation of two server queuing system.	**12**
	4.	**Inventory Control:** Elements of Inventory Theory, more complex inventory models, finite and infinite delivery rate model with and without back ordering, simulation of inventory systems.	**12**
	5.	**Evaluation of simulation:** length of simulation runs, variance reduction techniques. Project Management: PERT/CPM techniques, simulation of PERT networks. Model as components of information systems, modelling for decision support. Virtual Reality: the ultimate interactive model.	**12**
		Total Hours	**60**

TEXTBOOK	1. Wainer, A. G ; Discrete-Event Modeling and Simulation: A Practitioners Approach;CRC Press, Boca Raton, FL. 2. DingyüXue, Yang Quan Chen; System Simulation Techniques with MATLAB and Simulink, John Wiley & Sons,UK.
REFERENCE BOOK/SUGGE STED READING	3. J., J.S. Carson, B.L. Nelson, and D.M. Nicol; Discrete-Event System Simulation Banks. Prentice-Hall. 4. A.M. and W.D. Kelton; Simulation Modeling and Analysis, Law , McGraw-Hill, New York, NY.

Course: CLOUD TECHNOLOGIES			Semester: I
Course Code: PHDCA 706	LTP	4 0 0	Credits: 4

OBJECTIVE	To introduce the foundational concepts and technologies of cloud computing, including virtualization and service-oriented architecture, and to enable students to understand cloud service models, applications, and their growing significance in modern computing environments.		
COURSEOUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Explain the fundamental concepts of cloud computing, including historical developments, infrastructure comparisons, and principles of parallel and distributed computing. 2. Describe the architecture, service models, and deployment models of cloud computing, and analyze its technical foundations, benefits, limitations, and associated challenges such as scalability, security, and interoperability. 3. Identify key players and technologies in the cloud computing industry, evaluate virtualization techniques, and assess the development and application of cloud services across community and corporate environments. 4. Apply security concepts to cloud infrastructure, including data security, encryption, identity management, compliance, and network protection, while understanding strategies for compromise response and task programming in high-throughput environments. 5. Analyze advanced cloud computing topics such as energy-efficient computing, market-oriented cloud management, federated clouds, third-party cloud services, and mobile cloud usage.		
COURSEDETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Fundamentals of Cloud Computing**: What it is & what it is not?, The old IT infrastructure versus the cloud, www, Internet, Cloud and cloud computing, Motivation for Cloud Computing, A comparison of IT infrastructure options, Historical developments: Client-Server computing, Peer to Peer Computing, Distributed Computing, Cluster & Grid Computing, "**Principles**" of parallel and distributed computing- Eras of computing, parallel vs. Distributed computing, Elements of parallel of computing, Elements of Distributed of computing, Technologies of distributed computing: Service oriented computing and architecture.	**12**
	2.	**Introduction to High performance computing:** Technical foundations of Cloud Computing, Goals of Cloud Computing, Resource Sharing at various levels, Cloud Architecture, NIST USA Cloud Computing Model: Essential Characteristics, Delivery Models, IaaS, PaaS, Saas, Deployment Models, Public, private, Hybrid & Community, Pricing Model of Cloud Computing, Advantages & Disadvantages of Cloud Computing, Open challenges: Cloud definition, cloud	**12**

		interoperability and standards, scalability and fault tolerance, Security, trust and privacy, Organizational aspects	
	3.	**Companies in Cloud Computing:** Cloud computing Engines- GAE, EC2, Microsoft Azure, Virtualization: Characteristics of virtualized environment, taxonomy of virtualization techniques, Virtualization and cloud computing, pros and cons of virtualization, Technology examples, Flex Tenancy architecture, Pros & Cons of Cloud service development, Cloud application development, Cloud computing applications, Cloud Computing for everyone, Computing for Community & corporate.	**12**
	4.	**Security:** Securing the cloud-The security boundary, Security service boundary, security mapping, Data security- Brokered cloud storage access, storage location and tenancy, encryption, Auditing and compliance, Establishing identity and presence, Network security, Host security, compromise response, High-throughput computing: Task programming.	**12**
	5.	**Advanced topics in cloud computing**: energy efficiency in clouds, market based management of clouds- market oriented cloud computing; A reference model of MOCC technologies and initiatives supporting MOCC, Federated clouds / Inter Clouds, Third party cloud services- Meta CDN; Spot Cloud, Using the mobile cloud.	**12**
		Total Hours	60
TEXT BOOK	1. Furht , Borko, Escalante, Armando; Handbook of Cloud Computing , Springer, USA. 2. Thomas Erl etal; Cloud Computing: Concepts, Technology & Architecture ,Prentice Hall,USA.		
REFERENCE BOOK/SUGGESTED READING	3. Harjot Dhawan; A Road to Cloud Computing:A Beginner's Perspective, LAP Lambert Academic Publishing, USA. 4. Judith Hurwitz; Cloud Computing for Dummies, John Wiley & Sons, USA.		

Course: BIG DATA ANALYTICS			Semester:I
CourseCode: PHDCA 707	LTP	4 0 0	Credits: 4

OBJECTIVE	This course on Big Data Analytics consists of coherent body of ideas and methods to acquaint the student with the basic programs in the computational and human Intelligence field and their underlying theory. Students will be capable to quickly adapt to new technology in the field of Big Data, assimilate new information, and solve real world problems.		
COURSEOUT COMES	**Upon completion of the course research scholar should be able to:** 1. Apply computing techniques to solve real-world Big Data problems in the software industry. 2. Understand and evaluate different tools and technologies used in Big Data. 3. Recognize issues related to Big Data in the IT industry and find possible solutions. 4. Explore and contribute to research in Big Data with meaningful social impact. 5. Apply Big Data knowledge to address challenges faced by businesses and industries.		
COURSEDETA ILS	**Unit No.**	**Topic**	**Hours**
	1.	**Introduction**: Examples, data science articulated, history and context, technology landscape	**12**
	2.	**Data Manipulation at Scale :**Databases and the relational algebra ,Parallel databases, parallel query processing, in-database analytics ,Map Reduce, Hadoop, relationship to databases, algorithms, extensions, languages ,Key-value stores and NoSQL; tradeoffs of SQL and NoSQL	**12**
	3.	**Analytics :** Topics in statistical modeling: basic concepts, experiment design, pitfalls, Topics in machine learning: supervised learning (rules, trees, forests, nearest neighbor, regression), optimization (gradient descent and variants), unsupervised learning	**12**
	4.	**Communicating Results :** Visualization, data products, visual data analytics, Provenance, privacy, ethics, governance.	**12**
		Special Topics : Graph Analytics: structure, traversals, analytics, Page Rank, community detection, recursive queries semantic web.	**12**
		Total Hours	**60**
TEXT BOOK	1. Michael Berthold, David J. Hand ; Intelligent Data Analysis; Springer. 2. Bill Franks; Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics; John Wiley & sons.		

REFERENCE BOOK/SUGGESTED READING	3. Glenn J. Myatt; Making Sense of Data I; John Wiley & Sons. 4. Jiawei Han, Micheline kamber; Data Mining Concepts and Techniques; Elsevier.

Course: CRYPTOGRAPHY			**Semester: I**
CourseCode: PHDCA708	**LTP**	**4 0 0**	**Credits: 4**

OBJECTIVE	The objective of this course is to introduce students to the principles and practices of cryptography. It aims to provide a foundational understanding of classical and modern encryption techniques, cryptographic protocols, hash functions, and digital signatures. Students will explore both theoretical and applied aspects of cryptography, enabling them to secure data and communication in various digital systems.		
COURSE OUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Explain the basic concepts of cryptography, including classical encryption methods and block cipher principles. 2. Apply number theory and public key cryptography techniques, such as RSA, to secure communication. 3. Analyze various key management and exchange protocols including Diffie-Hellman and Elliptic Curve Cryptography. 4. Evaluate message authentication methods, hash functions, and digital signature techniques for data integrity and authenticity. 5. Assess real-world cryptographic applications in securing email, web communication, and systems through protocols and standards.		
COURSEDETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Overview of security** concepts, attacks, services, and mechanisms; Classical encryption techniques: Caesar cipher, monoalphabetic and polyalphabetic ciphers, transposition cipher; Steganography; Block cipher principles; Data Encryption Standard (DES), Triple DES, Blowfish, AES; Block cipher modes of operation; Key distribution and traffic confidentiality.	**12**
	2.	**Number theory basics:** Fermat's and Euler's theorems, Modular arithmetic, Primality testing, Chinese Remainder Theorem; Public key cryptography: RSA algorithm, key generation, encryption and decryption, security of RSA.	**12**
	3.	**Key management**: symmetric and asymmetric systems; Diffie-Hellman key exchange; Elliptic Curve Cryptography (ECC); Key agreement protocols: ISAKMP, OAKLEY.	**12**
	4.	**Message authentication codes (MACs):** requirements and security; Hash functions: MD5, SHA family; Digital signatures: Digital Signature Standard (DSS), RSA-based signatures; Birthday attacks and hash collisions.	**12**

	5.	**Email security:** PGP and S/MIME; IP security: Authentication Header, Encapsulating Security Payload (ESP); Web security: SSL/TLS, HTTPS; Secure Electronic Transactions (SET); Intrusion detection systems and firewalls; Real-world implementation challenges.	**12**
		Total Hours	**60**
TEXT BOOK	1. Behaviour A Frorouzan;Cryptography and Network Security;TMH. 2. Stallings, W. (2017). *Cryptography and Network Security: Principles and Practice* (7th ed.). Pearson.		
REFERENCE BOOK/SUGGE STED READING	3. Johannes A. Buchmann; Introduction to cryptography; Springer-Verlag. 4. Menezes, A. J., Van Oorschot, P. C., & Vanstone, S. A., *Handbook of Applied Cryptography*. CRC Press. 5. Paar, C., & Pelzl, J. *Understanding Cryptography: A Textbook for Students and Practitioners*. Springer. 6. Schneier, B. *Applied Cryptography: Protocols, Algorithms, and Source Code in C* , Wiley. 7. Kahate, A. , *Cryptography and Network Security*. McGraw-Hill Education.		

Course: MACHINE LEARNING			Semester: I
CourseCode: PHDCA709	LTP	4 0 0	Credits: 4

OBJECTIVE	The objective of this course is to introduce students to the fundamental concepts, techniques, and applications of Machine Learning. It aims to provide a strong theoretical foundation as well as practical skills in designing and implementing machine learning algorithms. Students will learn to analyze data, build predictive models, and evaluate their performance using statistical methods. The course covers both supervised and unsupervised learning approaches, including classification, regression, clustering, and dimensionality reduction. It also emphasizes real-world applications and the use of relevant tools and frameworks to solve complex problems across various domains.		
COURSE OUTCOMES	**Upon completion of the course research scholar should be able to:** 1. Have a good understanding of the fundamental issues and challenges of machine learning. 2. Have a good understanding of data, model selection, model complexity, etc. 3. Have an understanding of the strengths and weaknesses of many popular machine learning approaches. 4. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning. 5. Be able to design and implement various machine learning algorithms in a range of real-world applications.		
COURSE DETAILS	**Unit No.**	**Topic**	**Hours**
	1.	**Overview and Introduction to Bayes Decision Theory:** Machine intelligence and applications, pattern recognition concepts classification, regression, feature selection, supervised learning class conditional probability distributions, Examples of classifiers bayes optimal classifier and error, learning classification approaches	**12**
	2.	**Linear machines:** General and linear discriminants, decision regions, single layer neural network, linear separability, general gradient descent, perceptron learning algorithm, mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptrons: two-layers universal approximators, back propagation learning, on-line, off-line error surface, important parameters.	**12**
	3.	**Learning decision trees:** Inference model, general domains, symbolic decision trees, consistency, learning trees from training examples entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm continuous test nodes, confidence, pruning, learning	**12**

		with incomplete data.	
	4.	**Instance-based Learning:** Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability. Machine learning concepts and limitations: Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and realizable case, VC-dimension, fundamental algorithm independent concepts, hypothesis class, target class, inductive bias, occam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.	**12**
	5.	**Machine learning assessment and Improvement:** Statistical model selection, structural risk minimization, bootstrapping, bagging, boosting. Support Vector Machines: Margin of a classifier, dual perceptron algorithm, learning nonlinear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier...	**12**
		Total Hours	**60**
TEXTBOOK	1. E. Alpaydin, Introduction to Machine Learning, Prentice Hall. 2. T. M. Mitchell, Machine Learning, McGraw-Hill.		
REFERENCE BOOK/SUGGESTED READING	3. Vladimir N. Vapnik, Statistical Learning Theory, John Wiley and Sons. 4. J. Shawe-Taylor and N. Cristianini, Cambridge, Introduction to Support Vector Machines, University Press. 5. C. M. Bishop, Pattern Recognition and Machine Learning, Springer.		

Course: ADVANCED SOFTWARE ENGINEERING			Semester: I
CourseCode: PHDCA710	LTP	4 0 0	Credits: 4

OBJECTIVE	The objective of this course is to provide students with a comprehensive understanding of the principles, methodologies, and tools used in software engineering. It aims to equip learners with knowledge of software development life cycle models, requirements engineering, architectural design, project planning, software metrics, and quality standards. The course emphasizes both theoretical and practical aspects of software design, development, testing, and maintenance. Additionally, it introduces estimation techniques, risk management strategies, and reliability models to ensure the delivery of high-quality, maintainable, and reliable software systems.		
COURSEOUT COMES	**Upon completion of the course research scholar should be able to:** 1. Explain the nature of software crises, software processes, and life cycle models, and describe the significance of quality standards such as ISO 9001 and SEI-CMM in software development. 2. Apply requirement engineering techniques and modeling tools such as DFDs, ER diagrams, and data dictionaries to gather, analyze, and document software requirements in the form of a structured Software Requirements Specification (SRS). 3. Analyze and design software architecture using various architectural views and styles, and apply estimation techniques and cost models like COCOMO and Putnam for effective project planning and risk management. 4. Design software systems using principles of cohesion and coupling, develop function-oriented and object-oriented designs, and understand the process and models involved in software maintenance, reengineering, and configuration management. 5. Apply software metrics for measurement and quality analysis, and implement software testing techniques such as boundary value analysis, path testing, and regression testing to ensure software reliability and adherence to standards.		
COURSEDET AILS	**Unit No.**	**Topic**	**Hours**
	1.	**Introduction:** Software Crisis, Software Processes & Characteristics, Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models, Overview of Quality Standards like ISO 9001, SEI – CMM. Software Requirements analysis & specifications: Requirement engineering, requirement elicitation techniques like FAST, QFD & Use case approach, requirements analysis using DFD, "**data dictionaries**" data dictionaries& ER Diagrams, Requirements documentation, Nature of SRS, Characteristics & organization of SRS.	**12**

	2.	**Software Architecture:** Role of Software Architecture, Architecture views, Component and Connector view: Components, Connectors, Architecture style for C and C view: pipe and filter, shared data style, client server style, Evaluating Architecture. Software Project Planning:Size Estimation like lines of Code & Function Count, Cost Estimation Models, Static single & Multivariable Models, COCOMO, COCOMO-II, Putnam resource allocation model, Risk Management..	**12**
	3.	**Software Design:** Cohesion & Coupling, Classification of Cohesiveness & Coupling, Function Oriented Design, Object Oriented Design, User Interface Design. Software Maintenance: Management oFf Maintenance, Maintenance Process, Maintenance Models, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation. Software Metrics: Software measurements: What & Why, Token Count, Halstead Software Science Measures, Design Metrics, Data Structure Metrics, Information Flow Metrics	**12**
	4.	**Software Testing:** Testing process, Design of test cases, functional testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Path Testing, Data flow and mutation testing, Unit Testing, Integration and System Testing, Debugging, Alpha & Beta Testing, Regression Testing, Testing Tools & Standards.	**12**
	5.	**Software Reliability:** Importance, Hardware Reliability & Software Reliability, Failure and Faults, Reliability Models, Basic Model, Logarithmic Poisson Model, Calendar time Component...	**12**
		Total Hours	**60**
TEXTBOOK	1. K. K. Aggarwal, Y. Singh; Software Engineering; New Age International. 2. R. S. Pressman; Software Engineering – A practitioner's approach; McGraw Hill		
REFERENCE BOOK/SUGGE STED READING	3. P. Jalote; An Integrated approach to Software Engineering; Springer Publications. 4. R. Fairley; Software Engineering Concepts; Tata McGraw Hill. 5. Y. Singh; Software Testing; Cambridge University Press. 6. Stephen R. Schach; Classical & Object Oriented Software Engineering; IRWIN.		