BERHAMPUR UNIVERSITY

Syllabus

for

Pre-Ph.D. Coursework

(One Semester)

Department of Computer Science
Berhampur University
Berhampur-760007 (Orissa)

2020

BERHAMPUR UNIVERSITY

Syllabus for Pre-Ph.D. Coursework

(Applicable for Students Taking Admission from the Session 2020-21)

Objective of the Course

As per the requirements of the Ph.D. Regulations, a candidate has to undergo one Semester Coursework. On successful completion of the coursework a candidate can proceed for the registration process by following the due procedure as laid down in the Ph.D. Regulations of the University. The Coursework consists of 4 papers designed to equip a student with the essentials required to pursue the research program in the Department of Computer Science.

Sl. No.	Subject Code	Subject Title	Marks	Credits
1	**PPCOMP C101**	Research Methodology	100	4
2	**PPCOMP C102**	Design and Analysis of Algorithms	100	4
3	**PPCOMP C103**	Research and Publication Ethics	50	2
4	**PPCOMP S104**	Seminar Presentation based on Review of Literature	50	2
5	**Elective Courses** (A student has to opt for one elective course from the following list of elective courses)		100	4
	PPCOMP E111	Data Analytics & Machine Learning		
	PPCOMP E112	Intelligent Agents		
	PPCOMP E113	Agile Software Engineering		
	PPCOMP E114	Cyber Security		
		Total	**400**	**16**

Sub. Code: PPCOMP C101	**Research Methodology**	
	Credit: 4	**Core Course**
Pre-requisites: No pre-requisite required		
Objectives: ✓ To learn the foundations of research ✓ To understand the importance of setting the goal of research and research design ✓ To learn the use of various data analysis techniques and tools		

Unit – I 10 hours

Foundations of Research: Objectives, Motivation. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question. Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic and its importance

Unit – II 10 hours

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.
Measurement: Concept of measurement– Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Unit – III 10 hours

Data Analysis: Data Preparation, Analysis and Interpretation. Analysis of experimental results. Data repositories for Computer Science research
Writing Research Papers – Title, Abstract, organization of contents, interpretation of results, reference styles. Journals in Computer Science, Impact factor of Journals, i-index, h-index, Ethical issues relating to publishing, Plagiarism.

Unit – IV 10 hours

Tools and techniques for Research: Students are expected to learn preparation of documents, presentation slides, detection of Plagiarism/similarity index, and various data analysis activities using software tools such as MSOffice, LaTeX, Open Source tools.
Python Programming, Python Library, Web Programming, Database Access.

Books:

1. Research Methodology: Methods, and Techniques– C.R. Kothari
2. Business Research Methods – Donald Cooper & Pamela Schindler, Tata McGraw Hill
3. Core Python Programming, 2/E, Wesley J. Chun

Sub. Code: PPCOMP C102	**Design and Analysis of Algorithms**	
	Credit: 4	**Core Course**
Pre-requisites: Knowledge of algorithm and basic data structures		
Objectives: ✓ To review important data structures used in computer science ✓ To learn techniques for design of efficient algorithms ✓ To study techniques for evaluating the performance of algorithms		

Unit – I 10 hours

Arrays and their Applications; Sparse Matrix, Stacks, Queues, Priority Queues, Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Graphs, Sorting and Searching Algorithms; Hashing.

Unit – II 10 hours

Performance Analysis of Algorithms: Time and Space Complexities; Asymptotic Notation, Recurrence Relations.
Design Techniques: Divide and Conquer; Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound.

Unit – III 10 hours

Graph Algorithms: Breadth-First Search, Depth-First Search, Shortest Paths, Maximum Flow, Minimum Spanning Trees.

Unit – IV 10 hours

String Matching Algorithms, Parallel Algorithms for Sorting, Searching and Merging, Approximation Algorithms, Randomized Algorithms.

Complexity Theory: P and NP Class Problems; NP-completeness and Reducibility.

Books:

1. Introduction to algorithms−Coremen, Leisorsen and Rivest (PHI)
2. The design and analysis of computer algorithms−Aho, Ulman (Addition Wesley).

Sub. Code: PPCOMP C103	**Research and Publication Ethics**	
	Credit: 2	**Core Course**
Pre-requisites: No pre-requisite required		
Objectives: ✓ To be aware of research integrity, predatory publications and research misconduct ✓ To be informed about different indexing and citation databases		

Unit – I 4 hours

Philosophy and Ethics:
Introduction to philosophy: definition, nature and scope, concept;
Ethics: definition, moral philosophy, nature of moral judgements and reactions.

Unit – II 4 hours

Scientific Conduct:
Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconduct: falsification, fabrication, and plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

Unit – III 7 hours

Publication Ethics: definition, introduction and importance; Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.; Conflict 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

Unit – IV 15 hours

Open Access publishing, SHERPA/RoMEO online resources to check copyright & self-archiving policies, Software tools to identify predatory publications developed by SPPU, Journal finder/suggestion tools (JANE, Elsevier Journal finder, Springer Journal Suggester, etc.); Use of Plagiarism software like Turnitin, Urkund, and other open source tools; Indexing databases, Citation databases: Web of Science, Scopus, etc.; Impact factor of journals as per journal citation report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, g-index, i10 index, almetrics.

Books:

1. A. Bird, Philosophy of Science, Routledge.
2. P. Chaddah, Ethics in Competitive Research: Do not get scoped, do not get plagiarized.
3. Indian national Science Academy (INSA), Ethics in Science Education, Research & Governance http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Sub. Code: PPCOMP S104	**Seminar Presentation based on Review of Literature**	
	Credit: 2	**Core Course**
Pre-requisites: No pre-requisite required		
Objectives: ✓ To develop the ability to read and understand research papers ✓ To learn how to make technical presentations		

1. Students are expected to have an in-depth study of at least 05 research papers from reputed journals and conference proceedings in the area of his/her research interest.

2. Submit a report of 10-15 pages based on the research papers studied.

3. Give a seminar presentation explaining the work done in those papers and give a critical view of the research findings.

4. It is expected that a student demonstrates the ability to find research gaps which may lead to further work.

Sub. Code: PPCOMP E111	**Data Analytics and Machine Learning**	
	Credit: 4	**Elective Course**
Pre-requisites: Basic statistics and algorithms		
Objectives: ✓ To study techniques for analyzing large data sets ✓ To learn various machine learning algorithms in order to build intelligent systems ✓ To under the use of various optimization techniques		

Unit – I 10 hours

Data Objects and Attribute Types, Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity, Data Pre-processing, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization, Data Cube Technology, Multidimensional Data Analysis.

Unit – II 10 hours

Statistical Decision Theory, Linear Methods for Regression: Linear Regression Models and Least Squares, Subset Selection, Artificial Neural Network: Basic models of neural networks, Back propagation, Radial basis function network.

Unit – III 10 hours

Bayesian Methods, Support Vector Machines, Kohenon Self-organization Feature Maps, Learning Vector Quantization (LVQ), Convolutional neural networks, Recurrent neural networks, Deep Learning Neural Networks, Model Assessment and Selection: Bias, Variance and Model Complexity, Optimism of the Training Error Rate, Cross-Validation.

Unit – IV 10 hours

Principle of optimization, Traditional methods of optimization, Binary-Coded Genetic Algorithm (BCGA), Schema theorem of BCGA, Introduction to Particle Swarm Optimization and Ant Colony Optimization.

Books:

1. Data mining; Concepts and techniques by J. Han and M. Kamber (Morgan Kaufmann)
2. The Elements of Statistical Learning-Data Mining, Inference, and Prediction (Second Edition) By Trevor Hastie, Robert Tibshirani, Jerome Friedman (Springer Verlag, 2009).
3. An introduction to statistical learning with applications in R By G.James, D.Witten, T.Hastie, R.Tibshirani (Springer,2013).

Sub. Code: PPCOMP E112	**Intelligent Agents**	
	Credit: 4	**Elective Course**
Pre-requisites: algorithm and logical thinking		
Objectives: ✓ To understand the basic ingredients of an intelligent software ✓ To learn the design approaches for building intelligent software systems		

Unit – I 10 hours

Agents and environments, Structure of intelligent agents: reflex, model-based, goal-based, utility-based, learning agents, problem-solving by searching, informed search, adversarial search, games, Alpha-Beta pruning

Unit – II 10 hours

Knowledge and Reasoning: first-order logic, inferencing. Actions, Situations and Events. Planning: planning with state-space search, partial-order planning, hierarchical task network planning, conditional planning, multi-agent planning.

Unit – III 10 hours

Acting under uncertainty, uncertainty and rational decisions, design of a decision-theoretic agent, Bayes' Rules, Probabilistic reasoning: representation of knowledge in uncertain domains, inference in Bayesian networks, probabilistic reasoning over time, inference in temporal models, Hidden Markov models.

Unit – IV 10 hours

Learning in intelligent agents: inductive learning, learning decision trees, ensemble learning, explanation-based learning, Reinforcement learning: passive and active reinforcement learning.

Books:

1. Artificial Intelligence: A Modern Approach (3rd ed.). Stuart Russell and Peter Norvig (Prentice Hall) 2009.
2. An Introduction to Multi-Agent Systems (2nd ed.), Michael Wooldridge, Wiley, 2009.
3. Multi-Agent Systems - A Modern Approach to Distributed Artificial Intelligence (2nd ed.), G. Weiss (ed.), MIT Press, 2013

Sub. Code: PPCOMP E113	**Agile Software Engineering**	
	Credit: 4	**Elective Course**
Pre-requisites: Basic understanding of software engineering principles		
Objectives: ✓ To understand the challenges of today's dynamic software development requirements ✓ To learn how agile methods can handle the changing software development requirements		

Unit – I 10 hours

Introduction to Agile Software Development: Understanding how traditional software development works and its problems; Role of Agile practices in the world of software development & Tools used

Unit – II 10 hours

Agile Project Planning and Management: Requirement Analysis, Estimation techniques, Iteration planning, Introduction to development practices: TDD : Test Driven Development & Pair Programming, Introduction to QA Practices: Fail Fast & Automated functional testing, Introduction to Continuous Integration.

Unit – III 10 hours

Coding and testing practices: Practicing TDD and pair programming as alternative to traditional documentation; Configuring Continuous Integration tools; Automated function testing in detail, Source Control

Unit – IV 10 hours

Agile Software development and deployment: Iterative and incremental software development, Automated and scripted deployment strategies, Handling change requests

Books:

1. Agile Software Development with Scrum, Ken Schwaber, Mike Beedle, Prentice Hall
2. Agile Estimating and Planning by Mike Cohn, Prentice Hall PTR
3. Continuous Integration: Improving Software Quality and Reducing Risk, Paul M. Duvall, Steve Matys, Andrew Glover, Addison Wesley

Sub. Code: PPCOMP E114	**Cyber Security**	
	Credit: 4	**Elective Course**
Pre-requisites: Computer networks and Internet protocols		
Objectives: ✓ To understand various security threats in the cyber space ✓ To learn different counter measures to deal with security threats		

Unit – I 10 hours

Network Security Threats, Network security model, Cryptographic systems, Cryptanalysis, Symmetric key and Asymmetric Key Cryptography, Encryption and Decryption Techniques, Cryptographic Algorithms: Cryptographic hash, Message Digest, Data Encryption Standard, Advanced Encryption Standard, RSA.

Unit – II 10 hours

Security Threats and Vulnerability: Types of attacks on Confidentiality, Integrity and Availability. Vulnerability and Threats. Malware: Viruses, Worms, Trojan horses.
Database Security, Operating System Security: Designing Secure Operating Systems, OS Security Vulnerabilities.

Unit – III 10 hours

Security Counter Measures: Firewalls: Overall functioning, Features, User Management
Intrusion Detection System, Intrusion Prevention System, Public Key Infrastructure, Digital Signature.
Web Security: Web authentication, Injection Flaws, SQL Injection, Web Browser Security
Security issues in Wireless Networks

Unit – IV 10 hours

Cyber Crime and Cyber Terrorism, Ethical Hacking, Penetration Testing, Computer Forensics, International Standards for Cyber Security, Security Audit, Privacy and Ethics
Planning and Enforcing Security Policies: Planning Security Policies, Risk Analysis, Security Policies for an Organization.

Books:

1. Cryptography and Network Security Principles and Practices, William Stallings, PHI
2. Network Security and Cryptography, Bernard Menezes, Cengage Learning
3. Cybersecurity Essentials, Brooks Charles J., Christopher Grow, et al. John Wiley & Sons

****