Department of Computer Science & Applications
A

Revised Syllabus of

Ph. D. Course Work

in

Computer Science

Approved by BoS on dated 05-07-2019

(With effective from July 2019)

Session 2019-2020 and onwards

DR. HARISINGH GOUR UNIVERSITY, SAGAR (M.P)

(A Central University)

1. Name of the program : **Ph. D. in Computer Science**

2. Duration of the program : as per UGC ordinance 23A

(a) Minimum duration : as per UGC ordinance 23A

(b) Maximum duration : as per UGC ordinance 23A

3. Structure of the program:

Ph D. in Compuer Science Sem. I Credit Distribution

Semester	Core Course (CC) Credits	Elective Course (EC) Credits	Language Course (LN) Credits	Skill Based Course (SE) Credits	Total Credits
I	12	04	-	-	**16**
other Semester	**Synopsis approval and Thesis Work**				

4. The medium of instruction shall be English (during examination). However lectures may be in Hindi and English both.

5. Every student has to attain minimum of 75% of attendance in every course of this programme, failing to which the student will be debarred from appearing in the End Semester Examination.

6. Scheme of Examination:

(a) Mid Semester Examination (ME) : 20 Marks

(b) Internal Assessment (IA) : 20 Marks

(c) End Semester Examination (ESE) : 60 Marks

7. Internal Assessment (IA) :

(a) Theory: Each theory course shall have the methodology of Internal Assessment using assignment, presentation, group discussion, etc. depending on the number of students in the class and feasibility of adopting a particular methodology. The distribution of marks for internal assessment shall be as follows.

(i) Evaluation of the assignment.
Presentation, group discussion etc. : 15 marks

(ii) Attendance : 05 Marks

The marks of attendance shall be awarded as follows:

(i) 75 % and below : 00 Marks

(ii) > 75 % and upto 80 % : 01 Marks

(iii) >80 % and upto 85 % : 02 Marks

(iv) >85 % and upto 90 % : 03 Marks

(v) >90 % and upto 95 % : 04 Marks

(vi) >95 % : 05 Marks

Summary of Ph.D. Course Work (One Semester) in Computer Science
From July 2018 and onwards

Course Code	Title of Paper	Credits
Compulsory to all		
CSA-CC-141	Research Methodology	4
CSA-CC-142	Data Structure and Algorithms	4
CSA-CC-143	Review of Published research work	4
Opt any one of the followings		
CSA-EC-141	Data Mining	4
CSA-EC-142	Advance Computer Networks	4
CSA-EC-143	Parallel Computing	4
CSA-EC-144	Advance Operating System	4
CSA-EC-145	Graph Theory and Combinatiorics	4
CSA-EC-146	Advanced Pattern Recognition	4
CSA-EC-147	Stochastic Modeling & Simulation	4
CSA-EC-148	Compiler Design	4

Ph. D. Coursework I Semester

CSA-CC- 141	Research Methodology	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I **Introduction to Research Methodology:** Types of Research, Significance & Status of Research, Major Research areas in relevant subject, Major Journals & Publications, Identification & selection & formulation of a research problem, Hypothesis formulation, Developing a research proposal, Resources and Tools in research. Role of empirical studies, Ethics in general, Ethical issues and professional conduct in research, General moral imperatives.

(12 Hours)

UNIT -II **Qualitative and Quantitative Reasoning:** Qualitative Representations, Representing Mathematical Relationship, State, Time and Behaviours, Space and Shape, Modeling Assumptions, Model Formulation, Model development and testing, Reasoning Techniques, Causal Reasoning, Simulation, Comparative Analysis.

(12 Hours)

UNIT -III **Data Analysis:** What is data, Mathematical statistics, Statistical tools and techniques, Method for aggregation and visualization, Methods for finding associations: correlation and regression, Hypothesis testing, Statistical tests and pattern recognition.

UNIT- IV **Literature Survey:** Literature search strategy, writing critical reviews, identifying venues for publishing your research. Quality majors in research like impact factor, some research quality indicators, Abstracting and Indexing of Journals and Research papers

(12 Hours)

UNIT -V **Writing Research Papers and Review Process:** Preparing, writing and presenting research paper. conference paper, Importance of references, making use of referees' reports. Journal review process, Group exercise in reviewing research papers.

Thesis Writing: Planning the thesis, writing the thesis, Thesis structure, Writing up schedule, Oral examination and Viva Voce.

(12 Hours)

Essential Reading::

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
2. Basic of Qualitative Research (3rd Edition) By Juliet Corbin & Anselm Strauss, *Sage Publications (2008)*

Suggested Reading:

1. The Nature of Research: Inquiry in Academic Context By Angela Brew, Routledge Falmer *(2001)*
2. Fuzzy Sets and Fuzzy Logic: Theory and Applications, Klir, Pearson Educaiton.
3. Sastry, S. S., Introductory methods of numerical analysis, Pearson Education India.

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Ph. D. Coursework I Semester

CSA-CC-142	Data Structure Algorithms	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Introduction of Data Struction,Classification of Data Structure, Stack,Stack Operations, Applications of stack: Conversion of Infix to prefix and Postfix Expressions, Evaluation of postfix expression using stack.

(12 Hours)

UNIT -II Queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queue, Deque and Priority Queue. Link List : Singly Linked Lists,Circular Linked Lists-Doubly Linked

(12 Hours)

UNIT -III Tree and Graph: Tree, Forest, Binary tree, types of Binary tree,Binary tree traversals,Binary Serach Tree (BST) and Its traversal. AVL tree, Graph: types of Graph, BFS, DFS, DAG, minimum spanning trees - Kruskal's and Prim's algorithms, Shortest Paths using Dijakstra Algorithm. Winograd's and Strassen's matrix multiplication algorithms.

(12 Hours)

UNIT -IV Searching , Sorting and Hashing: Linear and Binary Searching, Sorting methods: - Selection, Bubble, Insertion, Radix, Quick, Merge, Bucket and Count. Hashing: Different Hashing methods, Hash Function.

(12 Hours)

UNIT -V Algorithms: Analysis of Algorithms: time and space complexity, Different Notations, Cases, Recurence Problem, Different types of algorithms design with examples. Huffman coding, Knapsack Problem,Travel Salesman Problem. String searching and Pattern matching, Knuth-Morris-Pratt algorithm.

(12 Hours)

Essential Reading:

1. T. H. Cormen, C.E. Leiserson and R.L.Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi.
2. E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub./Pitman, New Delhi/London.
3. K. Mehlhorn: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin.

Suggested Reading:

1. Gilles Dowek, Introduction to the theory of programming languges, Springer.
2. Bhubaneswar Mishra, Algorithmatic Algebra, Springer
3. Peter Brass, Advanced Dtas Structures (Cambridge University Press)
4. Jeff Edmonds, How to think about algorithms (Cambridge University Press)

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Ph. D. Coursework I Semester

CSA-CC-143	Review of Published Research Work	Credit: 4	L	T	P	C
		Max. Marks : 100	-	-	-	4

This paper will be covered literature survey on specific topic and candidate will write review report.

The Internet resources on a specific topic shall be used. Following are research oriented reading Material

Essential Material:

1. Roberto Cipolla, Computer Vision, springer
2. Ernesto Sanchez, Industrial Applications, of Evolutionary Algorithms, Springer.
3. Janos, J. Sarbo, Knowledge in formation : a Computational theory of Interperation, springer.
4. Liang Wang, Machine Learning for vision based motion analsysis, Springer.
5. Weisi Lin, Multimedia Analysis, processing and communicaitons, Springer.
6. Krishamurthy, Introductory theory of Computer Science(Affiliated East West).

Suggested Reading:

1. Jie Wu, Distributed System diesgn (CRC Press)
2. Radhakrishnan, Digital logic and computer organization.
3. Keyes, Securities Technology Handbook, CRC Press.
4. Gonzlez, Digital Image Processing 3E, Pearson Education.
5. Ananda S. Chowdhury, Computer Vision Guided Virtual Crraniofacial Surgery, Springer.
6. Nanda, Fuzzy Mathematical Concepts, Narosa.
7. Brain, R Hunt, A Guide to Matlab for begineers and experienced users (CUP)
8. Whitbeck, Ethics in Engineerng Practice and Research (Cambridge).

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Ph. D. Coursework I Semester

CSA-EC-141	Data Mining	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT- I Data warehouse: The building Blocks- Defining Features, data warehouses and data marts, overview of the components and metadata in the data warehouse. Defining the business requirements: Dimensional analysis, information packages- a new concept, requirements gathering methods, requirements

(12 Hours)

UNIT- II Data warehouse architectures: Metadata, operational data & operational databases. Data warehouse architecture model, 2-tier, 3tier & 4 tier data warehouses. OLAP and DSS support in data warehouses. Principles of dimensional modeling: Objectives, From Requirements to data design, the STAR schema, STAR Schema Keys, Advantages of the STAR Schema

(12 Hours)

UNIT- III Data Mining: Basic concept, technology and rules, platform tools, operational vs. Information systems, discussion of ethics & privacy issues with respect to invasive use, Data pre-processing and cleaning, Data visualization and exploratory data analysis.

(12 Hours)

UNIT- IV Data mining techniques: Exploration of data mining methodologies, decision tables, Decision trees, classification rules, association rules, clustering, statistical models & linear models, Performance evaluation.

(12 Hours)

UNIT -V Web mining: Introduction to web mining techniques, web basics and HTTP, data Sources on the web, personalization, working with logs, forms and cookies, user identification and path analysis, E-Metrics, Any other current topics on Data Mining.

(12 Hours)

Esstential Reading:

1. Jiawei Han, Micheline Kamber and Jian Pei (2011) Data Mining: Concepts and Techniques.
2. Matthew North (2012) Data Mining for the Masses.
3. Pang Ning Tan, M Steinbach, Vipin Kumar, Introduction to Data Mining, Addision Wesley.
4. Schalkoff, Pattern Recognition : Statisticsl Structural and Neural Approaches, Wiley India.

Suggested Reading:

1. Berson, Data Warehousing, Data Mining, and Olap, TMH.
2. Toll, M. Mitchell, Machine Learning, (India Higher Education)
3. Witten, Data Mining : Practical Machine Learning Tools and Techniques (Morgan Kaufmann)
4. Elbe Frank, Data Mining : Practical Machine Learning tools and technqiues (Elsevier India).
5. Manning, Introduction to information retrival (Cambridge).

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Ph. D. Coursework I Semester

CSA-EC-142	Advanced Computer Network	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Computer Networks and the Internet: Computer Networking and the Internet, Networking Devices, The Network edge, The Network core, Access Networks and Physical media, ISPs.

(12 Hours)

UNIT -II Networking Models: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing.

(12 Hours)

UNIT -III Network Routing: Routing and its concepts: Structure of a Router, Basic Router Configuration, Building a Routing Table, Static Routing, Dynamic Routing – Distance Vector Routing Protocol (RIPv1, RIPv2, EIGRP), Link State Routing Protocols (OSPF).

(12 Hours)

UNIT --IV LAN Switching: Switching and its concepts: Structure of a Switch, Basic Switch Configuration, Virtual LANs (VLANs), VLAN Trunking Protocol (VTP), Spanning Tree Protocol (STP), Inter-VLAN Routing.
Wide Area Networks (WANs): Introduction to WANs, Point-to-Point Protocol (PPP) concepts, Frame Relay concepts, Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT), IPv6.

(12 Hours)

UNIT -V Network Programming using Java: TCP sockets, UDP sockets (datagram sockets), Server programs that can handle one connection at a time and multiple connections (using multithreaded server), Remote Method Invocation (Java RMI) - Basic RMI Process, Implementation details - Client-Server Application.

(12 Hours)

Essential Reading:

1. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose, Keith W. Ross, Fifth Edition, Pearson Education.
2. Network Fundamentals, Mark Dye, Pearson Education.
3. Routing Protocols & Concepts, Rick Graziani, Pearson Education.

Suggested Reading:

1. LAN Switching & Wireless, Wayne Lewis, Pearson Education.
2. Accessing the WAN, Bob Vachon, Pearson Education.
3. Crptography and Network Security, Stallings, Pearson Education.
4. Mobile and Personal communication Services and Systems (institute of Electrical and Electronics, Raj Pandya.

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Ph. D. Coursework I Semester

CSA-EC-143	Parallel Computing	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Parallel Computer: Concept, need and requirement, various concepts in pipelining, issues involved in complex pipelining, configuring a parallel computer, Parallel Architecture: Vector processor, message passing and shared memory multiprocessors, Permutation.

UNIT- II Programming: Using sequential computing elements, data flow approach. Elementary Algorithms: Matrix manipulation, Graph connectivity and traversal, Tree traversal, Sorting and searching on PRAM.

UNIT -III Complexity of Parallel algorithms: Various processor interconnection schemes: mesh, hypercube, perfect shuffle etc., High Performance Computing approach for complex problems: problems in Computational Geometry,

UNIT- IV Permutations and Combinations, Fourier transforms, traversing combinational spaces, Decision and Optimization.

UNIT -V Task Scheduling: DAG, Priority of task, Homogenous and heterogeneous scheduling, different scheduling algorithms.

Essential Reading:

1. Ratan Ghosh, Rajat Moona, Phalguni Gupta, "Foundation of Parallel Processing" NAROSA.
2. V. Rajaraman "Elements of Parallel Computing" PHI.

Suggested Reading:

1. Selim Akl, "The Design and Analysis of Parallel Algorithms", PHI

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Ph. D. Coursework I Semester

CSA-EC-144	Advanced Operating System	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Device Drivers. Message Passing: Inter-process communication, group communication, broadcasting algorithms. Remote Procedure Call: RPC Model, stub generation, server management, parameter passing, call semantics, communication protocols, client-Server binding, exception handling, security, optimization.

UNIT- II Distributed Shared Memory: Architecture, consistency model, replacement strategy, thrashing, coherence, Naming in distributed systems, directory services, DNS.

UNIT -III Synchronization: Clock synchronization, event ordering, mutual exclusion, deadlock, election algorithms.

UNIT -IV Resource Management: Scheduling algorithm, task assignment, load balancing, load sharing. Process Management: Process migration, threads. File Systems. Protection and Security. Fault Tolerance.

UNIT -V Real time OS: pSOS, VxWorks, Case studies of some distributed OS: Hydra, Mach, Amoeba, etc.

Essential Reading:

1. A. S. Tanenbaum: Distributed Operating Systems, Prentice Hall of India, New Delhi.
2. G .F. Colouris, J. Dollimore and T. Kindberg: Distributed Systems: Concepts and Design, 2nd ed., Addison-Wesley, Reading, Mass.
3. S. J. Mullender (Ed.): Distributed Systems: An Advanced Course, 2nd ed., Addison-Wesley, Reading, Mass.

Suggested Reading:

1. P. K. Sinha: Distributed Operating Systems, IEEE Press, Los Alamos, California.
2. ED, Pracial Methods of Opetimization, 2nd Edi., Wiley India.
3. Raj Jain, The are of Comptuer systems Performance Analysis, Wiley India Pvt. Ltd.

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Ph. D. Coursework I Semester

CSA-EC-145	Graph Theory and Combinatorics	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Introduction of graph, types of graph, BFS and DFS.

(12 Hours)

UNIT -II Connectivity, Matchings, Hamiltonian Cycles, Colouring Problems.

(12 Hours)

UNIT- III Network flows, special classes of graphs, Introduction to Graph Minor theory.

(12 Hours)

UNIT -IV Combinatorics: Basic Combinatorial Numbers, Recurrence Relations, Inclusion-Exclusion Principle, Introduction to Polya Theory.

(12 Hours)

UNIT -V Probabilistic Method in Graph theory: Basic Method, Expectation, Chernoff bound, Lovasz Local Lemma.

(12 Hours)

Essential Reading:

1. J. H. Van Lint, R. M. Wilson, A Course in Combinatorics, Cambridge University Press, 1993.
2. N. Alon and J. Spenser, "Probabilistic Methods", John Wiley and Sons, 2nd edition, 2000.
3. R. Diestel, "Graph Theory", Springer-Verlag, 2nd edition, 2000.

Suggested Reading:

1. N.Deo, Graph Theory with applications to Engieering and Computer Science, Person Education.
2. F S Roberts, Applied Combinotrics, II Edition, (T&F).
3. Gupta, Operation Research (PP), (S Chand).

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Ph. D. Coursework I Semester

CSA-EC-146	Advanced Pattern Recognition	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Bayes classification, error probability, error bounds, Bhattacharya bounds, error rates and their estimation, parametric and nonparametric learning, density estimation, estimation of mixture distributions, classification trees.

(12 Hours)

UNIT -II Unsupervised classification, split/merge techniques, advanced hierarchical clustering algorithms, cluster validity, set estimation, optimal and suboptimal feature selection algorithms, k-NN rule and its error rate. Syntactic approach to pattern recognition.

(12 Hours)

UNIT -III Neural network models for pattern recognition; learning, supervised and unsupervised classification.

(12 Hours)

UNIT- IV Stochastic learning algorithm, feature analysis, fuzzy set theoretic models for pattern recognition.

(12 Hours)

UNIT- V Some advanced topics with applications, (e.g., neuro-fuzzy approach, genetic algorithms, data mining, case-based reasoning). Use of PR software.

(12 Hours)

Essential Reading:

1. K. Fukunaga: Introduction to Statistical Pattern Recognition, Academic Press, New York.
2. M. R. Anderberg: Cluster Analysis for Applications, Academic Press, New York, 1973.
3. A. K. Jain and R. C. Dubes: Algorithms for Clustering Data, Prentice Hall, Englewood Cliffs.
4. R. C. Gonzalez and M. G. Thomason: Syntactic Pattern Recognition: An Introduction, Addison-Wesley, Reading, Mass.
5. K. S. Fu: Syntactic Pattern Recognition and Applications, Prentice Hall, Englewood Cliffs.

Suggested Reading:

1. J. C. Bezdek: Pattern Recognition with Fuzzy Objective Function Algorithms, Plenum Press, New York.
2. G. J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, Englewood Cliffs.
3. B. D. Ripley: Pattern Recognition and Neural Networks, Cambridge University Press, London.
4. Y-H. Pao: Adaptive Pattern and Neural Networks, Addison-Wesley, New York.
5. R. J. Schalko: Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley.
6. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
7. Duda Richard O., Pattern Classification, 2 Edi. Vieley India.
8. Motwani, Randomized Algorithms (Cambridge).

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Ph. D. Coursework I Semester

CSA-EC- 147	Stochastic Modeling & Simulation	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Basics of Stochastic modeling, Markov chain theory, application of Markov chains, Transition Probability, Homogenous and non homogenous chains.

(12 Hours)

UNIT- II Stochastic Poisson process, different Poisson process dependent models. Parameter based probability distributions in Poisson Processes.

(12 Hours)

UNIT- III Switching system, Different types of switches, stochastic modeling of switches, Modeling of space division switch, Modeling of Knockout Switch.

(12 Hours)

UNIT- IV Stochastic modeling of different network systems, use of transition probabilities in modeling of computer system.

(12 Hours)

UNIT- V Study of Internet traffic share problem, Modeling & characterization of network traffic problems.

(12 Hours)

Essential Reading:

1. Medhi, J., Stuchastic Process, Wiley Publication.
2. Banks, J, Carson S and Nilson B L, "Discrete Event System Simulation "PHI.
3. Deo N "System simulation with digital computers" PHI.
4. Law A M and Kelton W D "Simulation Modeling and analysis" Mc Graw Hill.

Suggested Reading:

1. Geoffrey Gordon., 'System Simulation' – Prentice Hall of India Pvt. Ltd.
2. Maryanski F., 'Digital Computer Simulation', CBS Distributors.
3. Law Averillm, 'Simulation Modeling and Analysis', TMH.

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Ph. D. Coursework I Semester

CSA-EC-148	Compiler Design	Credit: 4	L	T	P	C
		Max. Marks : 100	4	0	0	4

UNIT -I Introduction**:** Compiler, phases and passes, bootstrapping, finite state machines and regular expressions and their applications to lexical analysis, implementation to lexical analyzers, lexical-analyzer generator; LEX-compiler, formal grammars, and their application to syntax analysis, BNF notation, ambiguity, LL(k) and LR(k) grammar, bottom-up and top-down parsers, operator precedence, simple precedence, recursive descent and predictive parsers, LR(k) parsers, parse table generation, YACC.

(12 Hours)

UNIT -II Syntax directed translation: Quadruples, triples, 3-address code, code generation for standard constructs with top-down and bottom-up parsers, translation of procedure calls, record structuring.

(12 Hours)

UNIT -III Code optimization: Loop optimization, DAG analysis, loop identification by flow dominance, depth-first search, reducible flow graphs, legal code motion, induction variables, data flow analysis, u-d and d-u chains, copy propagation, elimination of global sub-expressions, constant folding, code hoisting, forward and backward data flow equations, inter procedural data flow analysis.

(12 Hours)

UNIT -IV Code generation: Problems in code generation, code generator, register assignment and allocation problems, usage count, code generation from DAG, peephole optimization.

(12 Hours)

UNIT -V Symbol table: Data structure and management, runtime storage administration, error detection and recovery; Lexical, syntactic and semantic errors, case studies with real life compilers.

(12 Hours)

Essential Reading:

1. A. V. Aho, R. Sethi and J. Ullman: Compilers: Principles, Techniques and Tools, Addison-Wesley, California.
2. A. Appel: Modern Compiler Implementation in Java, Cambridge Univ. Press, London.

Suggested Reading:

1. Sipser, Introuction to Theory of Computation, Cengage Learning.

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