DDU Gorakhpur University, Gorakhpur

Department of Computer Science

Ph. D COURSE WORK

in

Computer Science

Department of Computer Science

DDU Gorakhpur University, Gorakhpur

Faculty of Science

Course Work for Ph. D. Computer Science Students

Every student admitted in Computer Science for the Ph. D. program will be required to pass a course work of minimum 21 credits. The division of this 21 credits course work is in three categories. Category-A (9 credits) courses are *compulsory* for all Ph. D. students of Computer Science. Category-B (6-credits) courses are *discipline-specific courses*. Category-C (6 credits) courses are *research theme- specific courses*.

Course Nature	**Course Code**	**Core Courses**	**Credit**
(Compulsory Course)			
Compulsory Course	STAT 600	Research Methodology	4+0
	LIBC 600	Research and Publication Ethics	1+1
	CSC 600	Computer Fundamentals and IT	1+1
	CSC 601	Credit Seminar	0+1
			09 Credits
	Elective Course (*Any two of the followings*)		
Discipline-Specific Courses	CSC 602	Design and Analysis of Algorithms	03
	CSC 603	Theory of Computation and Compiler Designing	03
	CSC 604	Software Engineering	03
	CSC 605	Database Systems	03
			06 Credits
	Open Elective Course (*Any two of the followings*)		
Research Theme-Specific Courses	CSC 606	Data Science	03
	CSC 607	Cloud Computing	03
	CSC 608	Machine Learning Techniques	03
	CSC 609	Internet Of Things	03
	CSC 610	Network and Information Security	03
			06 Credits
		Thesis	Non Credit
		Total	**21 Credits**

Program Outcome

At the end of Ph.D.course, the student will be able to:

1. Produce a well-developed research proposal plan that addresses question of significance in a specific area of Computer Science.

2. Demonstrate in-depth knowledge of a particular area in Computer Science and broad knowledge of other areas in Computer Science.

3. Choose an appropriate methodology with which to conduct the research work.

4. Understand the most advanced research in the area of Computer Science which is selected for the purpose of undertaking research by the student, i.e. have an in-depth literature survey.

5. Identify the resources as well as tools needed to perform the research process.

6. Continue with the ethical standards during the entire research work.

COURSE CONTENTS

Computer Fundamentals and IT

Course Code: CSC 600 **Credits: 1+1**

Course Outcomes: At the end of course, the student will be able to understand: 1.Computer fundamentals including hardware and peripheral devices.

2. Basics of MS-Word, MS-Excel and Power Point software.

3: Creating basic documents, worksheets, presentations with their properties

4. Experience working with email and recognize email netiquette.

Syllabus:

Unit 1: Computer Basics: Definition, Characteristics of Computers, Evolution of Computer, Generations of Computer, Classification of Computers, Applications of Computers, Computer System and its Components, Computer Memory, Memory Capacity, Input and Output Devices, Software and Hardware, System Software and Application Software, Operating System Definition and Functions, Working with Windows, File Management in Windows, System Utilities in Windows.

Unit 2: Introduction of MS-Word: The screen and its elements, Creating new documents, Writing and Simple Formatting, Page layout, Table, Pictures and Graphics.

Unit 3: Introduction of MS-Excel and Power Point: Basics of MS-Excel, Perform calculation on data, Manage worksheet, Analyze alternative data sets, Create and Manage slides, Insert and Manage Simple Graphics, Add sound and movements of slides.

Unit 4: Introduction of Internet and email: How to create e-mail, E-mail- sending a message, E-mail- attaching a document, How to use internet in research work.

Practicals:

Working with MS-Word: Prepare a word document of Ph. D. Synopsis, Prepare word document of Research Paper, Prepare word document of References.

Working with MS-Excel and Power Point: Prepare Tables and Charts (Pi-chart, Bar-chart), Insert pictures in a worksheet, Prepare Power Point presentation of the Ph.D. Synopsis, Prepare power point presentation having animation graphics and sound.

Internet and e-mail: Creating e-mail in different ways and websites, How to search research papers in Google Scholar and any Journal, How to search information related to research.

References:

1. Introduction to Information Technology, ITL Education Solutions, Pearson Education.
2. Introduction to Computer Science, ITL Education Solutions, Pearson Education.
3. Computer Fundamentals by P.K.Sinha & Priti Sinha, BPB Publications.

Seminar

Course Code: CSC 601 **Credits: 01**

The seminar paper will be related to the Research Theme- Specific Course of the candidate and the candidate should have to give a seminar presentation of it.

Discipline Specific Courses

Design and Analysis of Algorithms

Course Code: CSC 602 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Design new algorithms, analyze their asymptotic and absolute runtime and memory demands.
2. Find an algorithm to solve the problem.
3. Apply classical sorting, searching, optimization and graph algorithms.
4. Understand basic techniques for designing algorithms, including the techniques of recursion, divide-and-conquer, and greedy.

Syllabus

Introduction: Algorithms, Analysing Algorithms, Complexity of Algorithms, Growth ofFunctions, Performance Measurements, Comparison of Sorting Algorithms, Sorting in Linear Time.

Complexity Classes and Approximation Algorithms: Nondeterministic Algorithms, Fundamentals of NP-Hard and NP-Complete problems, vertex cover, independent set, Hamiltonian cycle, knapsack, set cover.

Tree and Graph Algorithms: Tree, definition, traversal algorithms (pre-order, post-order, in-order), Applications of Trees, Graph, BFS, DFS, connected components, minimum spanning trees, shortest paths.

Searching & Sorting: Searching, binary search trees, balanced binary, AVL trees and red-black trees, B-trees. Sorting, comparison-based sorting, quick sort, heap sort, merge sort: worst and average case analysis.

References:

1. Introduction to Algorithms, T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, 3rd Edition, Prentice-Hall of India Learning Pvt. Ltd.
2. Algorithm Design, J. Kleinberg and E. Tardos, 1st Edition, Pearson Education India,
3. Algorithms, Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, 1st Edition, Tata McGraw Hill.
4. Approximation Algorithms, Vijay V. Vazirani, Springer.
5. Introduction to Algorithms: A Creative Approach, UdiManber, Addison-Wesley.

Theory of Computation and Compiler Designing

Course Code: CSC 603 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:
1. Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.
2. Infer the equivalence of languages described by finite automata and regular expressions.
3. Devise regular, context free grammars while recognizing the strings and tokens.
4. Design pushdown automata to recognize the language.
5. Develop an understanding of computation through Turing Machine.

Syllabus

Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages. Universal machine, the universal and diagonalization languages.

Regular Languages and Finite Automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, minimization of finite automata.

Context-Free & Context-Sensitive Languages and Pushdown Automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, deterministic pushdown automata, closure properties of CFLs. Context-sensitive grammars (CSG) and languages.

Compilation and Implementation Phases: From regular expression to finite automata, Syntax Analysis (Parser): LL (1) grammar and top-down parsing, operator grammar, ambiguity and LR parsing.

References:

1) Introduction to Automata Theory, Languages and Computation, J.E.Hopcraft, R. Motwani and J.D. Ullman, Pearson.
2) Introduction to Computer Theory, Cohen, John Wiley.
3) Theory of Computation, T.C. Martin, Tata McGraw-Hill.
4) Theory of Computer Science: Automata, Languages and Computation, K.L.P. Mishra, N. Chandrasekaran, PHI.

Software Engineering

Course Code: CSC 604 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Gain basic knowledge in software engineering.
2. Identify requirements, analyze and prepare models.
3. Plan, schedule and track the progress of the projects.
4. Identify risks, manage the change to assure quality in software projects.
5. Apply testing principles on software project and understand the maintenance concepts.

Syllabus

Fundamental Concepts: Software life-cycle models, requirements specification, UML, design patterns, user interface design, coding and unit testing, integration and systems testing, debugging techniques, software quality - SEI CMM and ISO-9001.

Requirements Analysis and Specification: Formal requirements specification, Development of requirements specification, SRS Building Process, Specification Languages, Validation of SRS, metrics, monitoring and control, Object Oriented analysis.

Software Project Planning and Architecture:Software Cost Estimation Techniques, Project Scheduling & Tracking, Project Team Standards, software configuration management, role of Software Architecture, Architecture Views, Component and Connector View.

Software Testing and Reliability:Strategies & Techniques, Debugging, Software Maintenance, Software Reliability and Availability Models, Software Reengineering, Cleanroom Approach, Software Reuse.

References:-

1) An Integrated Approach to Software Engineering, IIIrd Edition, PankajJalote, Narosa Publishing House.
2) Software Engineering: Principles and Practices Waman S. Jawadekar, Tata McGraw-Hill.
3) Software Engineering: A Practitioner's approach, Roger S. Pressman, McGraw-Hill.
4) Software Engineering, Ian Sommerville, Pearson Education.
5) Fundamentals of Software Engineering, Rajib Mall, Prentice Hall India.

Database Systems

Course Code: CSC 605 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1.Various concepts and application of distributed database.
2. Measure query cost and optimize query execution
3. Design distributed database for better resource management
4. Apply appropriate security techniques database systems.
5. Implement advanced data models for real life applications.

Syllabus

Basic Concepts: Object-oriented and object relational databases, logical databases, web databases, distributed databases, data warehousing and data mining.

Database System Architecture and Selected Issues: Data Abstraction, Data Independence, Data Definition and Data Manipulation Languages, Data Security, Transaction Management, Introduction to Query Processing and Query Optimization, Concurrency Control, Recovery Techniques.

Distributed DBMS: Distributed database design – fragmentation, allocation criteria, Distributed data dictionary management, Distributed database administration.

Partitioned Networks and Storage Mechanisms in Distributed DBMS: Checkpoints & Cold Starts, Distributed Transactions Management, 2 Phase Protocols, Architectural Aspects, Node & Link Failure Recoveries, Concurrency Control, 2 Phases Locks, Distributed Deadlocks.

References:-

6) Data Base System Concepts, KorthSilberschatz, McGraw Hill.
7) Fundamentals of Database Systems, R. Elmasriand S.B. Navathe, Pearson Education Asia.
8) Database Management Systems, Raghu Ramakrishnan, McGraw-Hill Education.
9) Distributed Databases Principles & Systems, Tata McGraw-Hill Education.

Research Theme- Specific Courses

Data Science

Course Code: CSC 606 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Underlying concepts related to data science.
2. Statistical data analysis techniques utilized in decision making.
3. Various machine learning concepts to be utilized for solve data science problems.
4. Use data mining software to solve real-world problems.

Syllabus

Introduction:Data Science Process, Data preparation & Management, Data Acquisition & Preprocessing Techniques, Data Cleaning, Selection, Integration, Transformation and Reduction, Mathematical Statistics & Probability, Distributions and Hypothesis Testing.

Data Modeling, Data Warehousing & Data Mining: Statistical Inference, Exploratory Data Analysis and Visualization, Predictive Modeling, Decision Tree, Classification, Model Evaluation & Ensembles, Hierarchical, Density Based Clustering, Outlier Detection, Clustering Performance Evaluation, Spatial Databases, Multimedia Databases, Time-series & Sequence, Text databases, Web Semantics. Big Data Technology & Computing, Big Data Architecture,

Machine Learning:Explore New Data Sets, Implementing Machine Learning Comprehensive Set, Learning Algorithms from Scratch, Data Preprocessing, Scikit Learning, Library for Machine Learning, Feature Engineering, Model Selection, Performance Metrics, Hyper-parameter Optimization, Deep Learning.

Exploratory Data Analysis: Data Analysis, Descriptive Statistics, Univariate and Multivariate Exploratory Data Analysis, Data Engineering, Natural Language Processing, Web Scraping Applications, Real-Time Data, Streaming Data Analytics.

References:

1) R for Data Science, G. Grolemund, H. Wickham, 1st Ed., O'Reilly.
2) Python Data Science Handbook, Jake VanderPlas, O'Reilly.
3) Introduction to Data Mining, P. Tan, M. Steinbach, A Karpatne, V. Kumar, 2nd Ed., Pearson Education, 2018.
4) Python for Data Analysis: Data Wrangling with Pandas, NumPy and iPython, W. McKinney, 2nd Ed., O'Reilly.
5) Mining the Web: Discovering Knowledge from Hypertext Data, SoumenChakrabar, Morgan-Kaufmann.
6) An Introduction to Statistical Learning with Applications in R, G James, D Witten, T Hastie and R Tibshirani, Springer Texts in Statistics, Springer.

Cloud Computing

Course Code: CSC 607 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Basics of cloud computing technology, i.e. concepts, strengths and limitations.
2. Cloud architecture, service as well as all the delivery models.
3. Different cloud services offered from variouscloud service providers.
4. Data storage and its processing in Cloud.
5. Various cloud computing issues such as cloud data security,various cloud attacks.

Syllabus

Understanding Cloud Computing: Overview of Computing Paradigm: Grid Computing, Cluster Computing, Distributed Computing, UtilityComputing, Cloud Computing- Definition, Characteristics,Advantages & Disadvantages, Cloud Service Providers, Cloud Service Model-SaaS, PaaS, IaaS.

Cloud Service Models: Infrastructure as a Service: IaaS definition, Introduction to virtualization, Different approaches to virtualization,Hypervisors, Machine Image, Virtual Machine(VM), Platform as a Service: PaaS definition,Service Oriented Architecture, Cloud Platform and Management: Computation, Storage, Example: Google AppEngine, Microsoft Azure. Software as a Service: SaaS definition, Web 2.0, Example: Salesforce.

Service and Data management in Cloud: Service Level Agreements(SLAs), Billing & Accounting,understanding cloud-based data storage, Storage types: SQL and NoSQL Databases, Understanding DistributedFile systems, Managing Data and its Scalability.

Cloud Security and Simulation Tools: Infrastructure Security: Network level security, Host level security, Application level security, Data security andStorage: Data privacy and security Issues, Identity & Access Management, Access Control, Authentication incloud computing, Case study of CloudSim.

References:

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
2. Mastering Cloud Computing - Raj Kumar Buyya, Christian Vecchiola and S. TanuraiSelvi (TMH), 2012.
3. Cloud Computing for Dummies - Judith Hurwitz, R. Bloor, M. Kanfman, F. Halper (Wiley India Edition).
4. Distributed and Cloud Computing - Kaittwang Geoffrey C. Fox and Jack J Dongrra (Elsevier India) 2012.
5. Cloud Computing – Insights into New Era Infrastructure - Kumar Saurabh (Wiley Indian Edition), 2011.

Machine Learning Techniques

Course Code: CSC 608 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Basics of machine learning and terminologies associated with it.
2. Several machine learning algorithms with application specific examples.
3.Various machine learning problems and be able to solve them by applying appropriate machine learning algorithm.
4. Design application using machine learning techniques.

Syllabus

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression; Sum of Squares of Error; gradient descent; closed form; normal equations; features.

Classification problems; decision boundaries; nearest neighbor methods, Probability and classification, Bayesoptimal decisions, Naive Bayes and Gaussian class-conditional distribution. Linear classifiers: Bayes' Rule andNaive Bayes Model, Logistic regression, Neural Networks, Decision tree.

Ensemble methods: Bagging, random forests, boosting, Unsupervised learning: clustering, k-means, hierarchical agglomeration, Advanced discussion onclustering and EM, Latent space methods; PCA, Text representations; naive Bayes and multinomial models.

VC-dimension, structural risk minimization; margin methods and support vector machines (SVM), Support vectormachines and large-margin classifiers, Time series; Markov models; autoregressive models.

References:

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997, ISBN 0-07-042807-7.
2. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 2006.
3. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani,Springer, 2013.
4. Pattern Classification, 2nd Ed., Richard Duda, Peter Hart, David Stork, John Wiley & Sons, 2001.

Internet of Things

Course Code: CSC 609 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Underlying concepts of Internet of Things and factors that led to the emergence of IoT.
2. Design and program IoT devices
3. Design an IoT device to work with a Cloud Computing infrastructure
4. Transfer IoT data to the cloud and in between cloud providers

Syllabus

Introduction to IoT: IoT Technology & Applications, Issues & Challenges, Sensor Networks, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, Machine-to-Machine Communications, Software Defined Networking, SDN for IoT.

Basics of Programming for developing IoT: Introduction to Arduino and Python programming Implementation ofIoT with Raspberry Pi: Introduction to Raspberry Pi.

Data Management & Computing: Data Handling and Analytics, Bigdata management in IoT, Cloud Computing,IoT Network & Cloud Services, Introduction to Cloud Service Model, Sensor-Cloud, Fog Computing.

Case Studies: Smart Cities, Smart Homes, Surveillance applications, Vehicular networks - Connected Vehicles,Smart Lighting System, Weather Monitoring System, Smart Agriculture, Healthcare, Activity Monitoring.

References:-

1. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, Taylor & Francis Group, 2017, ISBN: 9781498761284.
2. AdrianMcEwen, “Designing the Internet of Things”, Wiley Publishers, 2013, ISBN: 978-1-118-430620.
3. VijayMadisetti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”,2014, ISBN:9780996025515.
4. Daniel Kellmereit, “The Silent Intelligence: The Internet of Things”, 2013, ISBN: 0989973700.
5. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley Publishers, 2010, ISBN 978-0-470-99765-9.

Network and Information Security

Course Code: CSC 610 **Credits: 03**

Course Outcomes:

At the end of course, the student will be able to understand:

1. Describe network security services and mechanisms.
2. Symmetrical and Asymmetrical cryptography.
3. Data integrity, Authentication, Digital Signatures.
4. Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.

Syllabus

Foundations of Information Security: Threats & Countermeasures, Cryptographic Algorithms and Protocols, Symmetric Encryption, Asymmetric Encryption, Random Number Generation, Access Control.

Internet Security Architecture: Basic Security Deficits of the Internet Protocol, IPSec, Security Associations, Security Protocols, Transport & Tunnel Mode, Authentication Header, Encapsulating Security Payload, Authentication & Key Management.

Transport Layer Security Protocols and Firewalls: Secure Socket Layer, Transport Layer Security, Secure Shell, Basic Firewall Concepts, Firewall Architectures, Packet Filtering, Proxy Services, Bastion Hosts.

Wireless and Mobile Networks Security: Specific Threats in Mobile Communications, Wireless Security in LAN Networks, IEEE 802.11, GSM/GPRS/UMTS, Security Concepts and Protocols, Electronic Payment Systems, Secure Electronic Transaction, CyberCash, iKey Protocols, Ecash (DigiCash).

References:

1. Network Security Essentials (Applications and Standards) by William Stallings, Pearson.
2. Information Security Principles & Practice, Mark Stamp, WILEY INDIA.
3. Cryptography and network Security, Fourth edition, Stallings, PHI/Pearson.
4. Cryptography & Network Security by Behrouz A. Forouzan, TMH.
5. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH.