



SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

**Course Curriculum of Ph.D. Degree Programme
in
Computer Science & Engineering
(Batch-2020-21)**

Credit Structure

Category	Credits
Departmental Major Subjects	6
Departmental Minor Subjects	5
Total	11

Note: The Research Scholar has to select the courses of minimum 6 credits from the Departmental Major Subjects and two minor courses on "Research Methodology in Science & Engineering" (3 Credits) and "Publication & Research Ethics" (2 Credits) as compulsory courses.

Course Structure: Ph.D. Degree (2020-21)

Departmental Major Subjects

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	CS-6001	Artificial Intelligence & Data Mining	3	0	0	3
2	CS-6002	Management Information Systems & Knowledge Management	3	0	0	3
3	CS-6003	Wireless Communication & Mobile Network Architecture	3	0	0	3
4	CS-6004	Pattern Classification & Coding Theory	3	0	0	3
5	CS-6005	Mobile Computing	3	0	0	3
6	CS-6006	Game Design	3	0	0	3
7	CS-6007	Neural Networks	3	0	0	3
8	CS-6008	Distributed Systems	3	0	0	3
9	CS-6009	Simulation & Modeling	3	0	0	3
10	CS-6010	Advanced Knowledge Management	3	0	0	3
11	CS-6011	Advanced Game Design	3	0	0	3
12	CS-6012	Data Mining & Warehousing	3	0	0	3
13	CS-6013	Wireless Sensor Networks	3	0	0	3
14	CS-6014	Cloud Computing	3	0	0	3

15	CS-6015	Cryptography & Information Security	3	0	0	3
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Departmental Minor Subjects

S. No.	Course Code	Course Title	L	T	P	Credit (s)
1.	RM-6001	Research Methodology in Science & Engineering	3	0	0	3
2.	RM-6003	Research & Publication Ethics	2	0	0	2

**Detailed Syllabus for Ph.D. Degree Programme
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Semester - I

(Departmental Major Subject)

CS-6001	L-T-P-C
Artificial Intelligence & Data Mining	3-0-0-3

Objective: *The aim is to study the basics of artificial intelligence & data mining. The scope is to develop prenominal ideas of A.I. based search techniques with optimum time complexity & generating modern algorithms for data classification & clustering.*

Course Content

Artificial Intelligence (AI), Representation of AI , Properties of internal representation, predicate calculus , other kinds of inference, Parsing Language , Expressing the rules of syntax , syntactic parsing , building an ATN Interpreter , Backtracking strategies, Graph strategies , uninformed graph-search procedures , heuristic graph-search procedures , measures of performance , Searching AND/OR graphs, Searching Game Trees, Rule based deduction systems , forward deduction system , backward deduction system , resolving within AND/OR Graphs , Control knowledge for rule based deduction systems, Planning decisions , Decision Theory, Robot Motion Planning, Game Playing.

Data Mining , Classification , Regression , Time Series Analysis , Data Prediction, Sequence Discovery, Fuzzy Sets, Fuzzy Logic , Information Retrieval, Decision Support System , Dimension Modelling , Pattern Matching, Nearest Neighbor, Agglomerative clustering , K-Means Clustering , Clustering on the basis of trend analysis.

Text/Reference Books

1. Principles of Artificial Intelligence. Nilsson N.J. Narosa Publishing House. 2002.
2. Introduction to Artificial Intelligence. Charnaik E. & McDermott D. Pearson Education. 2009.

3. Data Mining-Introductory & Advanced Topics. Dunham M. H. & Sridhar S. Pearson Education. 2008.

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Semester - I

(Departmental Major Subject)

CS-6002 L-T-P-C
Management Information Systems & Knowledge Management 3-0-0-3

Objective: *The aim is to study the fundamentals of Management Information System & Knowledge Management. The scope of study is to implement modern algorithms in decision support systems & e-security. The quantification of knowledge management is also another research challenge in this context.*

Course Content

Management Information System (MIS), Importance of MIS, Logical Foundations of MIS, Classification of Information Systems , Data & Information. Decision Support Systems (DSS), Characteristics of DSS, DSS Generators, Multicriteria. Modelling, Group Decisions, Expert Systems(ES), Components of ES, Expert System Applications, Benefits of ES , Limitations of ES , Knowledge Engineering , Fuzzy Logic in Business, Enhancing decision making. Security Information System , System Vulnerability , Internal & External Threats , Business Value of security & control. The Knowledge Management(KM) Landscape , Important dimensions of KM , KM Value Chain , Types of KM Systems , Structured Knowledge Systems , Quantification of KM.

Text/Reference Books

1. Management Information Systems. Laudon K.C. & Laudon J.P. Pearson Education. 2009.
2. Management Information Systems. Sadagopan S. PHI Learning Pvt. Ltd. 1997.
3. Management Information Systems. O'Brien J., Marakas G. & Behl R. Tata Mc-Graw Hill Education Pvt. Ltd. 2010.
4. Introduction to Knowledge Management. Bhunia C.T. Everest Publishing House. 2003.

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Semester - I

(Departmental Major Subject)

CS-6003	L-T-P-C
Wireless Communication & Mobile Network Architecture	3-0-0-3

Objective: *The aim is to study the basics of wireless communication & mobile network architecture. The scope of study is to develop new algorithms towards realizing nodes & their area determination. Security enhancement of mobile & grid networks is also another important aspect in this perspective.*

Course Content

Principles of Cellular Networks, TDMA, CDMA, Wireless Link Improvement Techniques
Satellite Communication, Satellite Parameters & Configuration, Capacity Allocation,
Cordless Systems, Wireless Local Loop, Mobile IP , Wireless Application Protocol. Wi-Fi
Protected Access , Overview of Bluetooth , Bluetooth Core Protocols , Bluetooth Usage
Models , Mobility Management , Hand-off, Hand-off types , Roaming Management,
Handoff detection , Strategies for hand-off detection , Channel assignment, Inter-system
handoff, PACS Network Signaling , Cellular Digital Packet Data , GSM Systems , Paging
Network Architecture , User Access Interface, Intersystem interface , Air Interface. Grid
Computing – Issues & Challenges , Design of Grid Topologies , Grid Security Aspects ,
Mobile Computing- Issues & Challenges, Security Enhancement Techniques in Mobile
Computing , Node Detection , Queueing Theory , System Dynamics Modeling,
Investigation of Optimum Communication Techniques.

Text/Reference Books

1. Wireless & Mobile Network Architectures. Lin Y. & Chlamtac I. Wiley India Pvt. Ltd. , 2001

2. Wireless Communications & Networks. Stallings W. Pearson Education, 2009.

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Semester - I

(Departmental Major Subject)

CS-6004	L-T-P-C
Pattern Classification & Coding Theory	3-0-0-3

Objective: *The aim is to study various pattern classification & information coding schemes. The scope of study is to develop modern techniques of pattern classification with optimum search time & high accuracy level. Application of coding theory in cryptography & analysis of security enhancement with respect to existing attacks is to be investigated.*

Course Content

Maximum Likelihood Estimation, Bayesian Estimation, Hidden Markov Models, Stochastic Methods , Linear Discriminant Functions & Decision Surfaces , Number Theory , Boltzmann Learning, Multilayer Neural Networks. Information Theory, Uncertainty & Information, Average Mutual Information & Entropy, Shannon-Fano algorithm, Huffman coding , Arithmetic coding, Perfect Codes, Hamming Codes , Method for generating cyclic codes, Quasi-cyclic codes, Shortened cyclic codes Cyclic redundancy check codes, BCH Codes , Reed-Solomon Codes , Nested Codes, Convolution Codes , Turbo Codes.

Text/Reference Books

1. Pattern Classification. Duba R.O., Hart P. & stork D.G. Wiley India Pvt. Ltd., 2006.
2. Information Theory, Coding & Cryptography. Bose R. Tata Mc-Graw Hill Education Pvt. Ltd. 2010.

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Semester - I

(Departmental Major Subject)

CS-6005
Mobile Computing

L-T-P-C
3-0-0-3

Objective: *Mobile technologies & applications will shape mobile computing & commerce into a new era of the 21st century whereby mobile devices are not only pervasive & ubiquitous, but also widely accepted as the main tool in commerce. Mobile Computing covers a broad range of aspects pertaining to mobile computing, mobile communication, mobile devices, & various mobile applications.*

Course Content

Introduction to mobile computing & Mobile Development Frameworks Architecture, Design & Technology, C/S architecture , n-tier architecture & WWW Mobile agent architecture, Wireless Transmission. Medium Access Control-Introduction, Near/Far Terminals , SDMA, FDMA, TDMA, CDMA. Wireless LANs & Ubiquitous Wireless Communications- Scenario of Mobile Communication, Mobile Communication Generations: 1G to 3G, 3rd Generation Mobile Communication Network, Universal Mobile Telecommunication System (UMTS). Mobile Computing-WWW architectures for mobile computing, Need of WAP, Benefits of WAP, Examples of WAP. Wireless Telecomm Networks, Generations of Mobile Networks, Evolution of GSM & GPRS. Developing Mobile Application with J2ME.

Text/Reference Books

1. Mobile Computing (Technologies & Applications). Jani N.N., Lakhtaria K.I., Jani A.N. & Kanabkar N. S.Chand & Company Ltd.. 2009.
2. Mobile computing. Talukder A.K. & Yavagal R.R. Tata McGraw-Hill Education. 2005.

3. Mobile Computing. Jeyasri A. V. Technical Publications. 2009.

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Semester - I

(Departmental Major Subject)

CS-6006
Game Design

L-T-P-C
3-0-0-3

Objective: *Introduction to game concepts, mechanics in general & electronic game design in particular. The course will cover areas such as design elements, idea refinement, design documents, prototyping. By applying these concepts you will develop a playable demo at the end of the course.*

Course Content

Analysis & comparison of games. You will look at several games & study their game mechanics & narratives. Output: Report on conclusions. Idea refinement. How do we make a good idea great? What elements can be added to improve the game? Output: Challenges to be solved & evaluated. The game design team. How do we create a good design team? What are the roles in the team & how do we keep from interfering with other roles? Exercises in group dynamics, group roles & responsibilities. Output: Hand in exercises & group work results for evaluation & feedback. Social games. New ways of gaming with a social twist. We look at social games on the web & how they work as well as none computerized social games such as Geocaching. Alternate Reality Games as a cross technique for gaming. Output: Report on how social game elements can be used in new ways. How can existing ideas be developed further? Small project.

Game prototyping. How to visualize & test ideas quickly. None computerized tools to try computerized ideas. Output: Small game prototype. Try out & evaluate another student's prototype. Final work. In a small team you will create a demo of an original idea. Output:

Presentation of demo game. Game design document & game demo will be handed in for evaluation & feedback.

Text/Reference Books

1. Challenges for Game Designers. Brathwaite B. Schreiber I. 1st Ed. Charles River Media. 2008.
2. Theory of Fun for Game Design. Koster R. 1st Ed. Paraglyph Press. 2004.

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Semester - I

(Departmental Major Subject)

CS-6007
Neural Networks

L-T-P-C
3-0-0-3

Objective: *The aim is to understand the basics of neural network & design some new topologies & models for learning strategies. The application of data mining based learning theory can be investigated. Application of neural networks in speech & pattern recognition is another research issue in this scenario.*

Course Content

Neural Networks Characteristics, Neural Networks Principles, Artificial Neural Net terminology, Model of a neuron, topology, learning types of learning supervised unsupervised, re-inforcement learning. Basic Hopfield Model , the perceptron , linear separability , Basic learning laws : Hebb's rule, Delta rule , Widrow & Hoff LMS learning rule, correlation learning rule, instar & outstar learning rules. Unsupervised Learning, competitive learning, K-means clustering algorithm & Kohonen's feature maps. Radial Basis, Function neural networks, Learning Laws in RBF nets, Recurrent networks, recurrent back propagation, Real Time Recurrent learning algorithm. Counter Propagation networks, CMAC networks, ART networks. Applications of Neural Nets, optimization, associative memories, vector quantization, control, Applications in speech & decision making.

Text/Reference Books

1. Neuro fuzzy & soft computing. Jang, Sun & Mizutoni. Pearson Education. 2005.
2. Introduction to Artificial Intelligence & Expert Systems. Patterson D.W. Pearson Education. 2005.

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Semester - I

(Departmental Major Subject)

CS-6008
Distributed Systems

L-T-P-C
3-0-0-3

Objective: *The aim is to study the concepts of distributed systems. Various approaches towards realizing optimum communication in distributed systems in the light of parallel computing is to be studied with relevant architecture & communication strategies.*

Course Content

Introduction & Architecture: Definitions & challenges. System models, Middleware, Client-Server models & its variants. Specifications of fundamental models: Interaction, Failure & Security models. Networking & Middleware Briefing: Networking & Internetworking, Internet protocols, APIs for internet protocols, External data representation & various marshaling environment. Distributed Objects & Remote Invocation: Communication between distributed objects, Remote procedure call, Sun RPC case study, Events & notifications. Synchronization: Introduction, Clocks, events & process states, Synchronizing physical clocks, Logical time & logical clocks, Global states, Distributed debugging. Transactions & Concurrency Control: Introduction, Transactions, Nested transactions, Locks, Optimistic concurrency control, Timestamp ordering, Comparison of methods for concurrency control. Overview of Distributed Transactions & Replication.

Text/Reference Books

1. Distributed Systems: concepts & Design. Coulouris G. 4th Ed. Pearson Education. 2006.
2. Distributed systems : principles & Paradigms. Tanenbaum A.S. & Steen M.V. Pearson Education. 2008.

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Semester - I

(Departmental Major Subject)

CS-6009
Simulation & Modeling

L-T-P-C
3-0-0-3

Objective: *The aim is to study the simulation strategies & the mathematical models on system concepts. Modification in deterministic, probabilistic, continuous, discrete, static physical, dynamic physical, static mathematical & dynamic mathematical models of simulation is a great research challenge in this context. New models in the light of system dynamics can be proposed in the light of statistical means like variance, expectation, curve fitting, regression & correlation.*

Course Content

Introduction: System definition & components, stochastic activities, continuous & discrete System, system modeling, types of models, static & dynamic physical models, Static & dynamic mathematical models. System simulation: Basic nature of simulation, technique of simulation ,comparison of simulation & analytical methods, types of system simulation , real time simulation, hybrid simulation, simulation of pure pursuit problem single server queuing system & an inventory problem, Monte Carlo simulation, Distributed Lag methods. System dynamics: Exponential growth models, exponential decay models, modified exponential growth models, logistic curves, generalization of growth models, System dynamics diagrams. Simulation of PERT networks: Critical path computation, uncertainties in Activity duration, Resource allocation & consideration.

Text/Reference Books

1. System Simulation. Gordon G. PHI Learning Pvt. Ltd. 2005.
2. System Simulation with Digital Computer. Deo N. PHI Learning Pvt. Ltd. 2006.

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Semester - I

(Departmental Major Subject)

CS-6010	L-T-P-C
Advanced Knowledge Management	3-0-0-3

Objective: The objective of the course is to develop some ideas regarding the knowledge types & modeling using UML.

Course Content

Knowledge Management - Knowledge Value, Knowledge Value Tree, Knowledge Acquisition. Declarative Knowledge – Subtypes, Declarative Knowledge Learning. Declarative Knowledge Representation. Procedural Knowledge – Definition, Capturing Procedural Knowledge. Tacit Knowledge - Definition, Varieties, Tacit Knowledge Capture. Explicit Knowledge - Definition, Explicit Knowledge Implicit, Capture for Knowledge Management. Process Knowledge & Concept Knowledge – Process Knowledge Workflow, Process Knowledge Applications, Concept Knowledge fundamentals. Knowledge Modeling using UML- Overview, UML applied to Knowledge Modeling, Knowledge Process, UML Decision Tree.

Text/Reference Books

1. UML for developing knowledge management systems. Rhem A.J. Auerbach Publications Taylor & Francis Group. 2006.
2. Knowledge Management in Modern Organizations. Jennex M. E. IGI Publishing. 2006.
3. Knowledge Management: Advanced Researches. Sanders M. 1st Ed. Clanrye International. 2015.

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Semester - I

(Departmental Major Subject)

CS-6011
Advanced Game Design

L-T-P-C
3-0-0-3

Objective: This course will be held in the form of an intensive workshop for designing & producing meaningful games. This course serves as an intensive group workshop where the students will produce a fully functional game by the end of the semester. The course will cover all aspects of the design process in dept. It will be done in the work of a group task where the group works together to complete a full functional digital or non-digital game.

Course Content

Pitch document. The group has to produce a pitch document & give a presentation of it.
Design document. This document will be a living document throughout the course. Every week this document has to be submitted. The content of this document will be the main topics of the course. Game Concepts - Introduction, Description, Key Features, Minimum System Requirements, Supporting Technology. Story- Full Game Story & Setting, Game Mechanics - Sample Game Play , Core Game Play / Game Flow, Game Modes- Player Design /Characters, NPC-Description, Stats, AI, Location, & Player Interaction. Physics, Artificial Intelligence Design-Algorithms Used, Algorithms Applied On. User Interface - Overview, HUD, & Menus. Visual Art - Sound & Music, Technical Analysis-Experimental Features, Major Development Tasks, Risks, Estimated Schedule, Market Analysis-Target Platform, Target Market, Target ESRB Rating, Target Genre, Top Performers, Legal Analysis. Cost Analysis-Resource Costs, Revenue Projection.

Text/Reference Books

1. The Game Design Reader: A Rules Of Play Anthology. Katie S. K. & Zimmerman E. MIT Press. 2005.
2. Game Mechanics: Advanced Game Design (Voices That Matter). Adams E. & Dormans J. New Riders. 2012.
3. Advanced Game Design with HTML5 & JavaScript. Spuy R. Apress, 2015.

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Semester - I

(Departmental Major Subject)

CS-6012	L-T-P-C
Data Mining & Warehousing	3-0-0-3

Objective: *In a knowledge-intensive economy, the ability of a company to compete effectively depends increasingly upon its ability to exploit its available knowledge resources. The focus of this course will be on understanding how some advanced information processing technologies can be used to raise organizational intelligence through exploratory data analysis methods such as data mining.*

Course Content

Introduction to Data Warehousing - Multi-dimensional Data Model & Schemas, OLAP Operations & Servers, Indexing OLAP Data Efficient Processing of OLAP Queries, Type of OLAP Servers: ROLAP vs. MOLAP vs. HOLAP, OLTP & Metadata Repository. Data Warehouse Architecture - The Design of A Data Warehouse, A Business Analysis Framework, The Process of Data, Warehouse Design, A 3-Tier Data Warehouse Architecture, Enterprise Warehouse, Data mart, Virtual Warehouse, Data Cleaning-Missing Values, Noisy Data, Data Cleaning as a Process, Data Integration & Transformation, Data Cube Aggregation Attribute Subset Selection, Dimensionality Reduction: Basic Concepts only. Data Mining - Introduction, Data Mining Functionalities, Characterization & Discrimination Mining Frequent Patterns, Associations, Correlations Classification & Prediction, Cluster Analysis, Outlier Analysis, Classification of Data Mining Systems, Data Mining Task Primitives, Integration of a Data Mining System with a Database or Data Warehouse System, Major Issues in Data Mining. Attribute-Oriented Induction: An Alternate Method for Data Generalization & Concept Description - Attribute-

Oriented Induction for Data Characterization, & Its Efficient Implementation, Presentation of the Derived Generalization, Mining Class Comparisons: Discrimination between Different Classes, Class Descriptions: Presentation of both Characterization & Comparison. Mining Frequent Patterns, Associations, & Correlations - Basic Concepts: Market Basket Analysis Frequent Itemsets, Closed Itemsets. Association Rules, Frequent Pattern Mining, Apriori Algorithm, From Association Mining to Correlation Analysis. Classification & Prediction - Introduction to Classification & Prediction, Basics of Supervised & Unsupervised Learning, Preparing the Data for Classification & Prediction, Comparing Classification & Prediction Methods, Classification by Decision Tree Induction, Attribute Selection Measures, Tree Pruning Scalability & Decision Tree Induction. Cluster Analysis - Introduction to Cluster Analysis, Types of Data in Cluster Analysis, A Categorization of major Clustering Methods, Partitioning Methods Centroid-Based Technique: K-Means Method, An Overview of Other Clustering Methods, Outlier Analysis Statistical Distribution-based Outlier Detection Distance-based Outlier, Detection Density-based Outlier Detection Deviation-based Outlier Detection. Data Mining Applications-Financial Data Analysis, The Retail Industry, The Telecommunication Industry, Biological Data Analysis, Other Scientific Applications, Intrusion detection, Examples of Commercial Data Mining Systems.

Text/Reference Books

1. Data Mining: Concepts & Techniques. Han J. & Kamber M. Morgan Kaufmann Publishers. 2000.
2. Advances in knowledge discovery & data mining. Fayyad U.M., Piatetsky-Shapiro G., Smyth P. & Uthurusanmy R. AAAI Press. 1996.
3. Business Intelligence: A Managerial Approach. Turban E., Sharda R., Aronson J.E. & King, D. Prentice Hall. 2010.
4. Data mining Explained - A manager's guide to customer-centric business intelligence. Delmater R. & Hancock M. Digital Press. 2001.

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Semester – I

(Departmental Major Subject)

CS-6013	L-T-P-C
Wireless Sensor Networks	3-0-0-3

Objective: *The aim is to study the basic architecture of Wireless Sensor Networks, describe the concepts, protocols, differences underlying the design, implementation, and applications of wireless sensor networks. The scope of the study is to implement improved protocols and evaluate new ideas for solving wireless sensor network design issues.*

Course Content

Introduction and Overview of Wireless Sensor Networks: Background of Sensor Network Technology, Basic Sensor Network Architectural Elements, Brief Historical Survey of Sensor Networks, Taxonomy of WSN Technology, Sensor Node Technology-Hardware and Software.

Applications of Wireless Sensor Networks: Range and Categorization of WSN Applications, Category 1 Applications- Home Control, Building Automation, Industrial Automation, Medical Applications; Category 2 Applications - Sensor and Robots, Reconfigurable Sensor Networks, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Wildfire Instrumentation, Habitat Monitoring, Nanoscopic Sensor Applications.

Medium Access Control Protocols for Wireless Sensor Networks: Fundamentals of MAC Protocols-Performance Requirements, Common Protocols, MAC Protocols for WSNs-Schedule-Based Protocols, Random Access-Based Protocols.

Routing Protocols for Wireless Sensor Networks: Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks-Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, Routing Strategies in Wireless Sensor Networks- WSN Routing Techniques, Flooding and its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing.

Transport Control Protocols for Wireless Sensor Networks: Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.

Middleware for Wireless Sensor Networks: WSN Middleware Principles, Middleware Architecture, Existing Middleware.

Network Management for Wireless Sensor Network: Network Management Requirements, Traditional Network Management Models, Network Management Design Issues, Example of Management Architecture: MANNA, Other Issues Related to Network Management- Naming, Localization.

Operating Systems for Wireless Sensor Networks: Operating System Design Issues, Examples of Operating Systems, TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS.

Performance and Traffic Management: WSN Design Issues-MAC Protocols, Routing Protocols, Transport Protocols, Performance Modeling of WSNs- Performance Metrics, Basic Models, Network Models, Case Study-Simple Computation of the System Life Span- Analysis.

Text/Reference Books

1. Wireless sensor networks: technology, protocols, and applications. Sohraby, Kazem, Minoli D. & Znati T. John Wiley & Sons, 2007.
2. Wireless Sensor Networks: an information processing approach. Zhao F. & Guibas L., Elsevier publication, 2004.
3. Wireless Sensor Networks: Principles and Practice. Hu F. & Cao X. An Auerbach Book, CRC Press, Taylor & Francis Group, 2010.

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Semester - I

(Departmental Major Subject)

CS-6014
Cloud Computing

L-T-P-C
3-0-0-3

Objective: *The objective of this course is to provide comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture and applications by introducing and researching state-of-the-art in Cloud Computing fundamental issues, technologies, applications and implementations and give ideas of key research areas of Cloud Computing and information systems, while providing foundations to enable further study and research.*

Course Content

Introduction and Overview of Cloud Computing: Introduction to Cloud Computing, Role of Networks in Cloud Computing, Deployment Models, Definition of private, public and hybrid cloud, role of web services, cloud types: cloud computing models, Service Models (XaaS): Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), benefits and challenges of cloud computing, private vs public clouds, role virtualization, business agility, benefits and challenges to cloud architecture, application availability, performance, security and disaster recovery, next generation cloud applications, difference between mainframe, distributed, cloud, grid computing, green computing, limitations of cloud computing, issues on cloud computing.

Cloud Computing Services: Cloud Security, Infrastructure Security, Reliability, availability and security of cloud services, performance and scalability of services, tools and technologies used to manage services, deployment of cloud services, cloud economics, cloud computing infrastructure for implementation of cloud-based services, choosing

platform for cloud deployment and services, applications of cloud services and business needs.

Load balancing in Cloud Computing: Cloud computing load balancing algorithms, different types of load balancing in cloud computing, cloud computing load balancing comparison with DNS Load Balancing, importance of load balancing in cloud computing, load balancing techniques in cloud computing, scheduling algorithms, load balancing policies, comparative study of algorithms, client-side load balancer using cloud, cloud load balancing services, cloud load balancers, various resource allocation strategies in cloud computing, comparison of load balancing algorithms used in cloud computing, load balancing issues among multifarious issues of cloud computing environment, load balancing in cloud computing using soft computing technique, load balancing in public cloud by division of cloud based on the geographical location.

Research issues in Cloud Computing: Study of different cloud computing algorithms, Literature review of various cloud computing strategies, Survey on cloud computing tools and methods.

Text/Reference Books

1. Enterprise Cloud Computing Technology Architecture Applications. Shroff G. Cambridge University Press.
2. Cloud Computing Bible. Sosinsky B. Wiley-India.
3. Load Balancing in the Cloud. DeJonghe D. O'Reilly Media, Inc.
4. Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center, Chee B. J. S. & Jr. C. F. CRC Press.
5. Distributed and Cloud Computing. Hwang K., Fox G. C., Jack J. & Dongarra M. K. Elsevier.
6. Cloud Computing, Theory and Practice. Marinescu D. C. Elsevier.
7. Cloud Computing, A Hands on approach. Bahga A. & Madisetti V. University Press
8. Cloud Computing, A Practical Approach. Velte A. T. & Velte T. J. & Elsenpeter R. TMH
9. Cloud Computing: Principles and Paradigms. Buyya R. K., Broberg J., Goscinski A. M. Wiley.
10. Mastering Cloud Computing, Foundations and Application Programming. Buyya R. K., Vecctiola C. & Selvi S. T. TMH

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Semester - I

(Departmental Major Subject)

CS-6015	L-T-P-C
Cryptography and Information Security	3-0-0-3

Objective: *The objective of this course is to identify computer and network security threats, classify the threats and develop a security model to prevent, detect and recover from the attacks, encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms, analyze existing authentication and key agreement protocols, identify the weaknesses of these protocols.*

Course Content

Introduction to Information Security and Number theory: Introduction: Security attacks to information systems, Need of Information Security; Security Architecture Data Security; Security Goals: Confidentiality, Integrity, Availability; Attacks on Security; Active vs. Passive Attacks; Authentication; Access Control; Non-Repudiation; Steganography; Basics of Cryptography; Cryptanalysis; Digital signatures; Public-key cryptography; Cryptographic Hash functions, Mathematical induction, Binomial Number theorem, Elementary Number Theory, Integer

Arithmetic, Modular Arithmetic, Factorization, Exponentiation and Logarithm, Primes, Matrices, Groups, Rings, Fields, Finite Fields, Threat model, Security services, Mechanisms for providing confidentiality, authentication, integrity, non-repudiation, and access control. Cryptography in data and communication security.

Conventional Cryptography: Conventional Cryptography: Cryptosystems and cryptanalysis. Block ciphers and stream ciphers. Confidentiality using encryption. Key distribution. Random number generation Message Authentication and Hash Functions: Cryptographic checksums, Message authentication codes. Hash functions. Security issues. Attacks and countermeasures, Digital Signatures and Strong Authentication: Digital signatures. One-way and mutual authentication protocols.

Cryptographic techniques and Cryptanalysis: Public-Key Cryptography: One-way functions. Trapdoor one-way functions. Public-key cryptosystems. RSA, Diffie-Hellman, ElGamal, and elliptic curve cryptosystems, Symmetric Cryptography, Data Encryption Standard (DES), Triple-DES, the Advanced Encryption Standard (AES), International Data Encryption Algorithm (IDEA), Blowfish, RC4, RC5, RC6, Asymmetric Cryptography, The Diffie-Hellman Algorithm, RSA, Elliptic Curve Cryptosystems (ECC).

Latest Security Technologies: SDN (Software-defined Networking), Virtual Dispersive Networking (VDN), Smart Grid Technologies, SAML & The Cloud, Distributed Ledger Technology principles, Blockchain, Advanced analytics, Context-Aware Behavioral Analytics, Deep learning, Gartner's CARTA approach, Bioprinting, Mobile Location Tracking, Behavioral Profiles, Third-Party Big Data, External Threat Intelligence, Tailor-made security, Early Warning Systems, Hardware authentication.

Security in Cloud and Distributed Systems: The cloud computing and distributed systems concepts and models: virtualization, cloud storage: key-value/NoSQL stores, cloud networking, Consensus in Cloud Computing, FLP proof, fault-tolerance in cloud using PAXOS, peer-to-peer systems, classical distributed algorithms, leader election, time, ordering in distributed systems, distributed mutual exclusion, distributed algorithms for failures and recovery approaches, Security As a Service, Distributed Ledger Technology principles, Network Security Practice: Authentication applications, Kerberos, Directory services, PGP and S/MIME, IP Security and Web security, Wireless Network Security: Wireless networking protocols and security issues, 801.11 protocols, attacks, and countermeasures, Blockchain, Apache Spark, Google's Chubby, Apache Zookeeper, HBase, MapReduce, Apache Cassandra, Google's B4, Microsoft's Swan.

Text/Reference Books

1. Cryptography & Network Security: Principles and Practices, W. Stallings, Pearson/PHI/Prentice Hall.
2. Introduction to Cryptography with coding theory, Wade Trappe, Lawrence C Washington, Pearson.
3. Modern Cryptography – Theory and Practices, W. Mao, Pearson Education.
4. Security in computing, Charles P. Pfleeger, Shari Lawrence Pfleeger, Prentice Hall of India.
5. Elementary Number Theory, David M. Burton, Tata McGraw Hill Publication.
6. A Course in number theory and cryptography, Neal Koblitz, Springer-Verlag Publication
7. Cryptography & Network Security, Behrouz Forouzan, Tata McGraw-Hill,
8. Handbook of Applied Cryptography, A. Menezes, P. van Oorschot, and S. Vanstone, CRC Press, 1996.
9. Cryptography and Network Security, William Stallings, Pearson Education India, 2008
10. Understanding Cryptography, Christof Paar & Jan Pelzl, Springer Heidelberg Dordrecht, London New York, 2010
11. Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, Tapscott, Don, and Alex Tapscott.
12. Big Data Analytics in Cybersecurity (Data Analytics Applications), Onur Savas, Julia Deng.
13. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, Wiley, 2011
14. Distributed Computing: Principles, Algorithms, and Systems, Ajay D. Kshem kalyani and Mukesh Singhal.
15. Applied Cryptography, Bruce Schneier, John Willey and Sons Inc, 2008
16. Complexity and Cryptography: An Introduction, John Talbot & Dominic Welsh, Cambridge University Press, 2006
17. Computer security and cryptography, Alan g. Konheim, John Wiley & Sons, Inc., 2007
18. Cryptography and Data Security, Dorothy Elizabeth and Robling Denning, Addison Wesley Publishing Company, 1982
19. An Introduction to Mathematical Cryptography, Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman, Springer Publication

**Detailed Syllabus for Ph.D. Degree Programme
in
Computer Science & Engineering**

Semester - I

(Departmental Minor Subject)

RM-6001	L-T-P-C
Research Methodology in Science & Engineering	3-0-0-3

Objective: *This course aims at training the PhD scholars towards acquiring competence in methodologies and methods involved in academic research. The course will expose scholars to various components of a scientific research which includes literature review, framing and testing hypothesis, designing research, data collection and analysis, writing reports and research proposals.*

Course Content

Module 01: Introduction

Introduction of Research Methodology: Approaches to Research: Resources or search engines available for gathering information and literature in related area, Critical review of available literature, Problem Identification & Formulation (finding research gaps), Research Question, Concept of a research proposal

Module 02: Research Design

Research Design: Hypothesis – Qualities of a good Hypothesis, Hypothesis Testing – Logic & Importance Features of a good research design; Concept and Importance of Research Design:–Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research.

Module 03: Data Collection, Preparation & Analysis

Data collection/ Sampling: Concepts of Statistical Population, Sample Size, Sampling Error, Probability, Practical considerations in sampling and sample size, Data Preparation and Data Analysis

Module 04: Research Documentation & Presentation

Research documentation and presentation: Structure and components of research report, Seminars and paper presentations

Text/Reference Books

1. Research Methodology and Scientific Writing. Thomas C. G. Ane Books Pvt. Ltd., 2015
2. Research Methodology: Methods and Techniques. Kothari, C. R. New Age International. 418p., 1990.
3. Research Methods: The concise knowledge base. K. Trochim, W. M. K. Atomic Dog Publishing. 270p.
4. Research Methods in Science and Engineering By Scott A. Gold (<https://www.crcpress.com/Research-Methods-in-Science-and-Engineering/Gold/p/book/9781482208290>)
5. Research Methods for Engineers. David V. Thiel
6. Writing for Science and Engineering: Papers, Presentations and Reports. Heather Silyn-Roberts

**Detailed Syllabus for Ph.D. Degree Programme
in
Computer Science & Engineering
Semester - I
(Departmental Minor Subject)**

RM-6003
Research & Publication Ethics

L-T-P-C
2-0-0-2

Objective: *This course provides awareness about the publication ethics and publication misconducts. Hands-on-sessions are designed to identify research misconducts and predatory publications. Indexing and citation databases, open access publications, research metrics and plagiarism tools will be introduced in this course.*

Course Content

Module 01: Philosophy & Ethics

Introduction to philosophy: Definition, nature and scope, concept, branches

Ethics: Definition, moral philosophy, nature of moral judgments and reactions

Module 02: Scientific Conducts

Ethics with respect to science and research, Intellectual honest and research integrity, Scientific Misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant Publications: Duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.

Module 03: Publication Ethics

Publication Ethics: Definition, introduction and importance, Best Practices/Standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication Misconduct: definition, concept, problems that lead to unethical behavior and vice-versa types, Violation of publication ethics, authorship, and contributor ship, Identification of Publication misconduct, complaints, and appeals, Predatory publishers and journals.

Module 04: Open Access Publishing

Open access publishing and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tools to identify predatory publications developed by SPPU, Journal finder tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Module 05: Publication Misconducts

Group Discussions: Subject specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad.

Software Tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Module 06: Databases and Research Metrics

Databases: Indexing databases; Citation databases: Web of Science, Scopus, etc.

Research Metrics: Impact factor of journal as per Journal citation report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, i10 index, almetrics.

Text/Reference Books

1. The Student's Guide to Research Ethics. Oliver P., Open University Press, 2003.
2. Responsible Conduct of Research. Shamoo A. E., Resnik D. B., Oxford University Press, 2003.
3. Philosophy of Science. Bird, A., Routledge, 2006.
4. A Short History of Ethics. Alasdair M., London, 1967.
5. Ethics in Competitive Research: Do not get scooped; do not get plagiarized. Chaddah P., (2018). ISBN:9789387480865
6. On Being a Scientist: A Guide to Responsible Conduct in Research. National Academy of Science, national Academy of Engineering, and Institute of Medicine. 3rd Ed., national Academies Press, 2009.