# COURSE CURRICULUM

# FOR

# DOCTOR OF PHILOSOPHY

# (COMPUTER ENGINEERING)

***(with effect from 2022-23)***


**DEPARTMENT OF COMPUTER ENGINEERING**

**Faculty of Engineering & Technology**

**Jamia Millia Islamia, New Delhi**

**(A Central University)**

**MMAJ Marg, New Delhi-110025**

Ph. 011 26980281

**COURSE WORK EXAMINATION RULES**

**for**

**DOCTOR OF PHILOSOPHY**
**(COMPUTER ENGINEERING)**

## 1. DURATION

6 months

## 2. ELIGIBILITY

The course is restricted to candidates who have registered for Ph.D. in the Department of Computer Engineering.

## 3. MEDIUM OF INSTRUCTION AND EXAMINATIONS

English

## 4. COMMENCEMENT OF THE COURSE WORK

As notified by The Dean, Faculty of Engineering & Technology, JMI

## 5. COURSE STRUCTURE

**L-T-P** stands for number of contact hours as **Lecture-Tutorial-Practical** in a week.

| **Paper Code** | **Title** | **Marks** | | | **L-T-P** | **Credits** |
|---|---|---|---|---|---|---|
| | | **Internal Assessment** | **Semester Exam** | **Total** | | |
| EEP 101 | Research Methodology | 25 | 75 | 100 | 3-1-0 | 4 |
| AFP 001 | Research Ethics | 12 | 38 | 50 | 2-0-0 | 2 |
| PHDCE 001 | Term Paper | 12 | 38 | 50 | - | 2 |
| | Elective – I | 25 | 75 | 100 | 3-1-0 | 4 |
| | Elective – II | 25 | 75 | 100 | 3-1-0 | 4 |

## Electives

The elective papers would be decided by the concerned supervisor(s) and HOD from the following list.

| Paper Code | Paper Name |
|---|---|
| PHD E01 | Cryptography & Network Security |
| PHD E02 | Data Analytics |
| PHD E03 | Advance Computer Networks |
| PHD E04 | Algorithm Design |
| PHD E05 | Advance Database Management Systems |
| PHD E06 | Machine Learning |
| PHD E07 | Parallel Computing |
| PHD E08 | Soft Computing |
| PHD E09 | Wireless Technologies for WSN & IoT |
| PHD E10 | Intelligent Systems |
| PHD E11 | Image Processing |
| PHD E12 | Deep Learning |
| PHD E13 | MOOCS |

*** The list of online courses to be cleared through MOOCs shall be floated in the respective semester after approval from the Board of Studies.**

## 6. ATTENDANCE

a. All students are supposed to attend every lecture. However, the attendance requirement for appearing in the examination shall be a minimum of 75% of the theory classes actually held.

b. Each one-hour classroom teaching shall account for one attendance unit.

c. The concerned teacher will take a roll call in every scheduled lecture and maintain a consolidated attendance record, which would be submitted to the Head of the Department at the conclusion of the session.

d. Attendance on account of participation in the conferences/seminars/workshops can be granted by the Dean on receipt of certificates or recommendations of the respective activity issued by the Head of the Department.

e. Attendance records displayed on Notice Board from time to time, in respect of short attendance, shall be deemed to be a proper notification and no individual notice shall be sent to students.

f. In case a student is found to be continuously absent from the classes without information for a period of 30 days, the concerned teacher shall report it to the Head of the Department.

g. Head of the Department may recommend for striking off the name of a student from rolls, after ensuring 'one month continuous absence', from all the concerned teachers.

h. A student, whose name has been struck off on account of long absence may apply to the Dean for readmission within 15 days of the notice of striking off the name.

i. A student with less than 75% attendance, in aggregate shall not be allowed to appear in the final examination. The Head of the Department shall recommend all such cases to the Dean of the faculty.

j. The Dean, on the recommendation of the Head of the Department, may consider the relaxation of attendance up to 10% on account of sickness and /or any other valid reason. No application for relaxation of attendance (duly certified by a Registered Medical Practitioner/Public hospital or a competent authority) will be entertained after 15 days from the recovery from illness etc.

k. A student detained on account of short attendance will start the course work afresh in the next academic session.

## 7. INTERNAL ASSESSMENT

a. Internal assessment, to be made by concerned teachers, will be based on presentations, minor tests and assignments.

b. The concerned teachers shall submit the compiled internal assessment marks to the Head of the Department, on the conclusion of teaching of the current semester.

c. The Head shall display a copy of the compiled sheet, of internal assessment marks of all the papers, before forwarding it to the controller, i.e. at the conclusion of the semester.

d. A promoted candidate, who has to reappear in the examination of a paper, will retain internal assessment marks.

e. In the case of re-admission, the candidates shall have to go through the internal assessment process afresh and shall retain nothing of the previous year.

## 8. EXAMINATIONS

Prescriptions for conducting semester examinations of theory papers after the conclusion of each of the semesters are presented in the following table:

| | | |
|---|---|---|
| a. | Mode | Written only. |
| b. | Duration | 03 Hours. |
| c. | Total Marks | 75 |
| d. | Passing Criteria | The minimum pass marks in each theory subject shall be 50% including internal assessment. |

## 9. SPAN PERIOD

All the students shall have to complete the coursework within a total period as specified in Ph.D. Ordinance of JMI.

# SYLLABUS

| Cryptography & Network Security | |
|---|---|
| **Paper Code** | **PHD E01** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Modular Arithmetic, Linear congruence, Primality testing, Factorization, Chinese Remainder Theorem, Quadratic congruence, Fermat's Theorem, Euler's Theorem, Galois Field, Euclidean and Extended Algorithm, Diophantine equation. Exponentiation and logarithm, Need for network security, Security approaches, Principles of security, Types of Attacks, Services and Mechanisms.<br>**UNIT- II**<br>Block Encryption, Symmetrical key cryptography: DES rounds, S-Boxes, IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography, Advance Encryption Standard AES. Public key cryptography: Knapsack, RSA: keys generating, encryption and decryption. El-Gamal, Elliptical curve cryptography, use of public key cryptography Digital signature, DSS, Zero-knowledge signatures.<br>**UNIT- III**<br>Message Digest algorithms: Length of HASH, uses, Message Digest 4 and 5: algorithm (padding, stages, and digest computation.) SHA1 and SHA512: Overview, padding, stages. Message Authentication Codes (MACs).<br>**UNIT- IV**<br>Authentication Methods, Passwords, Single sign on, Entity Authentication, Authentication Protocol, Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication, Key version numbers, |

KDC's Certification Revocation, Inter domain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution.

**UNIT – V**

Electronic mail security, IP security, Network management security. Security for electronic commerce: Secure Socket Layer. Secure Electronic Transaction, Pretty Good Privacy, Intruders and Viruses, Firewalls, Intrusion Detection system.

**References / Text Books:**


- Stallings, W., Cryptography and Network Security: Principles and Practice, 3rd ed., Prentice Hall Print.,2003
- Bruce Schneier, Applied cryptography, 2nd Edition Wiley
- Kaufman, c., Perlman, R., and Speciner, M., Network Security, Private Communication in a public world, 2nd ed., Prentice Hall Print, 2002.
- Behrouz A Forouzan, Cryptography and Network Security, 2nd Edition 2010, McGraw Hill.


**Computer Usage / Software Requires:**

Python/ Java/ C++

| Data Analytics | |
|---|---|
| **Paper Code** | **PHD E02** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Introduction to Data Mining: KDD, Process and Data Mining; KDD Steps; Types of Data for Data Mining, Data Mining Functionalities: Data Characterization, Data Discrimination, Mining Frequent Patterns, Association, Correlation, Classification, Prediction, Cluster Analysis, Outlier Analysis, and Evolution Analysis; Classification of Data Mining Systems; Data Mining Task Primitives; Major Issues in Data Mining.<br>Data Preprocessing: Introduction to Data Preprocessing; Descriptive Data Summarization: Measuring and Central Tendency and Dispersion of Data; Visualization of Descriptive Data Summaries; Data Cleaning: Handling Missing Values, Filtering Noisy Data – Binning Method; Data Integration; Data Transformation: Smoothing, Aggregation, Generalization, Normalization and Feature Selection. Regression Analysis.<br>**UNIT- II**<br>**Data Analysis Fundamentals:** Data Analysis foundations – Univariate, Bivariate and Multivariate Analysis; Graph Data, Kernel Methods; Working with High Dimensional data; Dimensionality reduction methods.<br>**UNIT- III**<br>**Frequent Pattern Mining:** Frequent Itemsets, Maximal and Closed Itemsets, and Association Rules; Support and Confidence; Apriori Algorithm for Mining Frequent Itemsets Using Candidate Generation; Generating Association Rules from Frequent Itemsets; Improving the Efficiency of Apriori Algorithm; FP-Growth Algorithm for Mining Frequent |

Itemsets without Candidate Generation; Mining Closed Frequent Itemsets;
Sequence Mining, Graph Pattern Mining.

**UNIT – IV**

**Classification Rule Mining:** Introduction to Classification and Prediction; Classification by Decision Induction; Attribute Selection Measures: Information Gain, Gain Ratio, and Gini Index; Bayesian Classification: Bayes' Theorem, Naïve Bayesian Classification; Classifier Accuracy Measures, Bagging and Boosting; Lazy Learners: K-Nearest- Neighbour Classifier; Prediction; Support Vector Machines, Introduction to Linear Discriminant Analysis.

**UNIT – V**

**Cluster Analysis:** Introduction to Cluster and Clustering; Features Required for Clustering Algorithms; Data Types and Dissimilarity Measures in Cluster Analysis; Categorization of Clustering Methods; Representative based Clustering: K-means algorithm, Kernel K-means, EM Clustering; Hierarchical Clustering; Density based Clustering algorithms; Introduction to Graph Clustering.

**References / Text Books:**


1. Zaki and Meira : Data Mining & Analytics – Cambridge University Press, 3rd Edition.
2. Ethem Alpaydin : Introduction to Machine Learning – MIT Press, 3rd Edition
3. Jiawei Han, Micheline Kamber: *Data Mining Concepts and Techniques*, 2nd Edition, Morgan Kaufman Publishers.
4. Tan, Steinbach and Kumar: Introduction to Data Mining – Pearson Publication.


**Computer Usage / Software Requires:**

## Advanced Computer Networks

| | |
|---|---|
| **Paper Code** | **PHD E03** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Network Services & Layered Architecture: Traffic characterization and quality of service, Network services, High performance networks, Network elements, Basic network mechanisms, layered architecture.<br>**UNIT- II**<br>ISDN & B-ISDN: Over view of ISDN, ISDN channels, User access, ISDN protocols, Brief history of B-ISDN and ATM, ATM based services and applications, principles and building block of B-ISDN, general architecture of B-ISDN, frame relay.<br>**UNIT- III**<br>ATM Networks: Network layering, Switching of virtual channels and virtual paths, applications of virtual channels and connections. QOS parameters, traffic descriptors, ATM service categories, ATM cell header, ATM layer, ATM adaptation layer.<br>**UNIT- IV**<br>Interconnection Networks: Introduction, Banyan Networks, Routing algorithm & blocking phenomenon, Batcher-Banyan networks, Crossbar switch, three stage class networks. Rearrangeable Networks: Re-arrangeable class networks, Folding algorithm, Bens network, looping algorithm.<br>**UNIT – V**<br>ATM Signaling, Routing and Traffic Control: ATM addressing, UNI signaling, PNNI signaling, PNNI routing, ABR Traffic management. TCP/IP Networks: History of TCP/IP, TCP application and Services, Motivation, TCP, UDP, IP services |

and Header formats, Internetworking, TCP congestion control. Queue Management: Passive & active, QOS in IP networks- Differentiated and integrated services.

**References / Text Books:**

- ISDN & B-ISDN with Frame Relay, William Stallings, PHI.
- ATM Fundamentals, N. N. Biswas, Adventure books publishers, 1998.
- High Performance TCP/IP Networking, Mahbub Hassan, Raj Jain, PHI, 2005.
- High Speed Networks and Internets, William Stallings, Pearson edu., 2002.

**Computer Usage / Software Requires:**

## Algorithm Design

| | |
|---|---|
| **Paper Code** | **PHD E04** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Review of Algorithm Analysis: Asymptotic notations, Rate of growth of functions, Recurrence analysis, Master's theorem and its proof, Time and space trade-off, Algorithms complexity analyses, Searching and Sorting algorithms, Lower bounds of searching and sorting.<br>**UNIT- II**<br>Design Techniques: Divide and Conquer technique, Greedy algorithms, Dynamic Programming, Backtracking, Branch and Bound.<br>**UNIT- III**<br>Advanced Data Structures: B-Trees, Red-black trees, Disjoint Sets, Union by Rank. Graph Algorithm: BFS, DFS, strongly connected components, All-Pairs Shortest Paths, Maximum Flow.<br>**UNIT- IV**<br>Advanced Design: Randomized algorithms, Amortized analysis, Approximate algorithms, Online algorithms.<br>**UNIT – V**<br>Pattern Matching and Computational Complexity: Naïve string matching, Rabin-karp matcher, FSA based matching, KMP string matcher; Complexity classes – P, NP, NP-Hard and NP-complete, Unsolvable problems, NP-Completeness and Reducibility, Examples and proofs of NP-complete problem, Cook's theorem. |
| **References / Text Books:** | • T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice Hall India, 1990.<br>• J Kleinberg, E Tardos, Algorithm Design, Pearson, 2014.<br>• R. Neapolitan, K Naimipour, Fundamentals of Algorithms, 4ed, Jones & Bartlett, 2011. |

- V. Aho, J. E. Hopcraft, J. D. Ullman, The Design and Analysis of Computer
  Algorithms, Pearson, 1974.
- E Horwitz, S Sahni, Fundamentals of Computer Algorithms, University Press, 2008.
- R Motwani, P Raghavan, Randomized Algorithms, Cambridge University Press,
  1995.
- NPTEL Lectures for Algorithms


**Computer Usage / Software Requires:**

## Advanced Database Management System

| | |
|---|---|
| **Paper Code** | **PHD E05** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Muiltivalued and Join Dependency, Normal Forms, Rules about functional dependencies. Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model, Null Values and Partial Information.<br>**UNIT- II**<br>Deductive Databases: Datalog and Recursion, Evaluation of Datalog program, Recursive queries with negation. Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols, Design of Parallel Databases, Parallel Query Evaluation.<br>**UNIT- III**<br>Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions and Saga, Long Duration Transactions, Weak Levels of Consistency, Transaction Work Flows, Transaction Processing Monitors. |

**UNIT- IV**

Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action: ECA Rules, Query Processing and Concurrency Control, Compensation and Databases Recovery

Image and Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures – R-tree, k-d tree, Quad trees, Content Based Retrieval: Color Histograms, Textures, etc., Image Features, Spatial and Topological Relationships, Multimedia Data Formats, Video Data Model, Audio & Handwritten Data, Geographic Information Systems (GIS)

**UNIT – V**

WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, Commercial Systems. Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries. Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule Discovery

Case Study: Oracle Xi

**References / Text Books:**


1. Elmarsi, Navathe, Somayajulu, Gupta, “Fundamentals of Database Systems”, 4th Edition, Pearson Education, 2007
2. Garcia, Ullman, Widom, “Database Systems, The complete book”, Pearson Education, 2007
3. R. Ramakrishnan, “Database Management Systems”, McGraw Hill International Editions, 1998
4. Date, Kannan, Swaminathan, “An Introduction to Database Systems”, 8th Edition Pearson Education, 2007
5. Singh S.K., “Database System Concepts, design and application”, Pearson Education, 2006.
6. Silberscatz, Korth, Sudarshan, “Database System Concepts”, Mcgraw Hill, 6th Edition, 2006

7. D. Maier, “The Theory of Relational Databases”, 1993, Computer Science Press, Rokville, Maryland
8. Ullman, J. D., “Principals of database systems”, Galgotia publications, 1999
9. Oracle Xi Reference Manual

**Computer Usage / Software Requires:**

- MYSQL, Oracle

| Machine Learning | |
|---|---|
| **Paper Code** | **PHD E06** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I** Introduction: Statistical learning: function estimation, the machine learning framework (model training, loss functions, optimization, regularization and validation). Parameter Estimation: Maximum Likelihood Estimation (MLE), Maximum a Posteriori (MAP) Estimation. Correlation and Regression, Bayes Optimal Classifier, Naïve Bayes Classifier<br>**UNIT- II** Supervised Learning: Optimization methods: Gradient Descent. Regression: Polynomial Regression, Multivariate Regression, Extensions to Linear Models. Classification: Logistic Regression, Multiclass classification, One vs Rest, Linear Discriminant Analysis, Quadratic Discriminant Analysis. Resampling Methods: Cross Validation, Bootstrap, Linear Model Selection and Regularization.<br>**UNIT- III** Additive and Reduction Methods: Generalized additive models, Adaptive Boosting, Gradient Boosting, Random Forest, Principal Component Analysis, Singular Value Decomposition, t-SNE.<br>**UNIT- IV** Graphical Models: Bayesian Networks: d-separation. Sequential Modelling: Hidden Markov Models (Forward Algorithm, Viterbi Algorithm, Forward-Backward Algorithm). Conditional Random Fields, Recurrent Neural Networks.<br>**UNIT – V** Applications of Machine Learning: Text Classification, Image Classification, Language Modelling, Distributional Semantics, Speech Recognition, Information |

Extraction, Question Answering, Machine Translation, Advance topics in Machine Learning.

**References / Text Books:**

1. **An Introduction to Statistical Learning** by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, Springer 2013.
2. **Pattern Recognition and Machine Learning** by Christopher Bishop Springer 2006.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning (ESL), Springer, 2009Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms (UML), Cambridge University Press, 2014.

**Computer Usage / Software Requires:**

- Python, sklearn, Tensorflow, Keras, Google Colab

| Parallel Computing | |
|---|---|
| **Paper Code** | **PHD E07** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I** Parallel system , Parallel computing, architectural classification schemes, Evolution of computer Architecture ,Parallel architecture, superscalar processor, Vector processors, Principle of multithreading, latency-hiding techniques, multi core processors, GPU, massive parallel processors, Cache coherence and synchronization mechanism , Arithmetic mean performance, geometric performance, harmonic performance, Performance laws, Amdahl's law, Gustafson's law, Sun and Ni' law, Evaluating parallel programs, Debugging and evaluating parallel program empirically<br>**UNIT- II** Pipeline, Design and analysis of pipeline and system based on it, optimal no. of stages, pipeline hazards and their solutions, Bernstein's criteria, dependency analysis, flow dependency, anti-dependency, output dependency, dependency flow graph, case study of recent processor pipelines.<br>**UNIT- III** Instruction scheduling, ILP, Out of order Execution, Tomasulo algorithm, Branch predictions, pipeline and branch predictor of recent processors, Collision free scheduling, Reservation table and stations. Case study of recent processor Architecture.<br>**UNIT- IV** Design and analysis of parallel algorithms, Preliminaries, decomposition techniques, characteristics of tasks and interactions, mapping techniques for load balancing, methods for containing interaction overheads, parallel algorithm models, the task/channel model, Foster 's design methodology, boundary value problem, finding the |

maximum, n-body problem, sorting, searching, solving linear equations, matrix multiplication, Parallelizing sequential algorithms, SIMD algorithm for multiplication, PRAM and VLSI model

**UNIT – V** Parallel Programming, Cluster programming using MPI, Multi core programming using OPEN MP, Programming massive parallel processors using CUDA, GPU, OPENCL, OPENACC

**References / Text Books:**


- Michael J. Quinn, "Parallel Computing theory and practice", TATA McGraw Hill
- Ananth Gramma, Anshul gupta, George Karypis & Vipin Kumar, "Introduction to parallel computing", Pearson Education.
- Michael J. Quinn, "Parallel Programming in with MPI and OpenMP" , Pearson Education
- Barry Wilkinson & Michael Allen, "Parallel Programming techniques and Applications using networked work stations and parallel computers", Pearson Education
- Kai Hwang, "Advanced Computer architectures, Parallelism, Scalability & Programmability", McGraw Hill.
- John L. Hennessey and David A. Patterson, "Computer Architecture – A quantitative approach", Morgan Kaufmann / Elsevier Publishers, 5th. Edition, 2012.
- David B. Kirk and Wen-mei W. Hwu, Programming Massively Parallel Processors, A hands on approach, Morgan Kaufman publishers,Elsevier.
- Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, 2011.

- Michael J Quinn, “Parallel programming in C with MPI and OpenMP”, Tata McGraw Hill,2003.
- 4. David B. Kirk and Wen-mei W. Hwu, “Programming Massively Parallel Processors”,Morgan Kaufmann, 2010.
- Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta, “Introduction to Parallel Computing”, Second Edition, Pearson Education Limited, 2003.
- Shameem Akhter and Jason Roberts, “Multi-core Programming”, Intel Press, 2006.
- Ian Foster, “Designing and Building Parallel Programs: Concepts and Tools for Parallel Software Engineering”, Addison Wesley Longman Publishing Co., USA, 1995.
- David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture: A hardware/ Software approach” , Morgan Kaufmann / Elsevier Publishers, 1999.
- OpenMP Programmer’s Manual.
- MPI Programmer’s Manual


**Computer Usage / Software Requires:**

## SOFT COMPUTING TECHNIQUE

| | |
|---|---|
| **Paper Code** | **PHD E08** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I** |

INTRODUCTION

Introduction to Soft Computing, Hard vs. Cost Computing paradigm, Constituents and Features of Soft Computing Approaches, Artificial Neural Networks, Fuzzy Logic, Genetic algorithm, Intelligent systems, Machine Intelligence, Applications of Soft computing.

**UNIT- II**

**ANN BASICS**

Function of Neuron, Biological Neuron, Artificial Neuron, Basic Model of ANN: connections, weights, bias, Activation functions, ANN architectures and characteristics, McCulloch-Pitts Neuron, Hebb Learning algorithm, Linear seperability, XOR problem, ANN Learning Types, Learning Rules.

**UNIT- III**

**NEURAL NETWORK ARCHITECTURES**

Perceptron, Multi-layer perceptron, ADALINE, MADALINE, Back-propogation training algorithm, Improving Network convergence, Network weight initialization techniques. Performance Metrics.

Auto and Hetero Associative Memory Networks, Bi-directional AM networks, Feedback Networks: Hopfield Networks.

Unsupervised learning: Kohonen Self-organizing feature map, Applications of ANN.

**UNIT- IV**

**FUZZY LOGIC**

Introduction to Fuzzy logic, Fuzzy set theory, Fuzzy set vs. Crisp set, Fuzzy relation & Crisp relation, Fuzzy logic

operations, Tolerance & Equivalence relations, Membership functions, Features of membership functions, Membership value assignment, Basic Fuzzy arithmetic. Various T-norms and T-conorms.

Fuzzification methods, Defuzzification methods, Fuzzy rules, Fuzzy If-Then rule, Fuzzy rule base system, Fuzzy inference system: Models of FIS. Applications of Fuzzy logic.

**UNIT – V**

**GENETIC ALGORITHM**

Introduction to Genetic algorithm: working principle, encoding, fitness function, reproduction, Inheritance, cross-over, Modern variants of GA, Applications of Genetic algorithm.

**References / Text Books:**


- S. Haykin, "Neural Networks: A Comprehensive Foundations" Pearson.
- Sivanandam & Deepa, "Principles of Soft Computing Techniques", Wiley Publication.
- Karray and Silva, "Soft Computing & Intelligent Systems Design", Pearson Education.
- Rajasekaran & Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", PHI.
- Timothy J Ross, "Fuzzy Logic with Engineering Applications", Wiley.
- David E Goldberg, "Genetic Algorithm in Search, Optimization & Machine Learning", Pearson


**Computer Usage / Software Requires:**

- MATLAB

| | Wireless Technologies for WSN & IoT |
|---|---|
| **Paper Code** | **PHD E09** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Cellular Standards: Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Picocells, Handoff, 1st, 2nd, 3rd and 4th Generation Cellular Systems (GSM, CDMA, GPRS, EDGE,UMTS), Mobile IP, WCDMA .<br>**UNIT- II**<br>WLAN: Wi-Fi Organizations and Standards: IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS & Power-Save, IEEE 802.11 Standards,802.11- 2007,802.11a/b/g, 802.11e/h/I,802.11n<br>**UNIT- III**<br>Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.<br>**UNIT- IV**<br>Deployment, Configuration, Routing: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self configuring localization systems, sensor management Network Protocols: Issues in designing |

MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network. Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.

**UNIT – V**

Data Storage, Manipulation & Applications of WSN : Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique. Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring. WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

**References / Text Books:**


1. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education
2. Wireless Communications and Networking; By: Stallings, William; Pearson Education Pte. Ltd.
3. Bluetooth Revealed; By: Miller, Brent A, Bisdikian, Chatschik; Addison Wesley Longman Pte Ltd.
4. Wilson , “Sensor Technology hand book,” Elsevier publications 2005.
5. Andrea Goldsmith, “Wireless Communications,” Cambridge University Press, 2005
6. Mobile and Personal Communications Services and Systems; 1st Edition; By: Raj Pandya; PHI
7. Fundamentals of Wireless Communication by Tse David and Viswanath Pramod, Cambridge University press

8. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd.
9. 3G Networks: Architecture, protocols and procedures based on 3GPP specifications for UMTS WCDMA networks, By Kasera, Sumit, Narang, and Nishit, TATA MGH
10. Wireless Sensor Networks: information processing by approach, ZHAO, FENG, GUIBAS and LEONIDAS J, ELSEVIER
11. Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks" John Wiley & Sons Limited 2008.

**Computer Usage / Software Requires:**

- Python, NS3

| Intelligent Systems | |
|---|---|
| **Paper Code** | **PHD E10** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>Computational Intelligence, Agents and Environments, Rationality, Performance Measures, Omniscience, Learning and Autonomy, Nature of Environments, Task Environments, Structure of Agents, Agent Programs, Simple Reflex Agent, Model based Reflex Agents, Goal based Agents, and Utility based Agents, Learning Agents.<br>**UNIT- II**<br>Proposition Logic, Equivalence, validity and Satisfiability, Resolution, Forward and Backward Chaining, First Order Logic, Unification, Inference, Inference rules for quantifiers, Reduction to propositional Inference, Resolution Refutation, Conjunctive Normal Form of FOL, Completeness of Resolution, Knowledge Engineering in FOL.<br>**UNIT- III**<br>Introduction to Logical Programming, Facts, Rules & Queries in Prolog, Matching & Proof Search, Recursion in Prolog, Lists, Arithmetic & Operators, Definite Clause Grammar, Cuts and Negation, Database Manipulation and collecting Solutions, Working with Files.<br>**UNIT- IV**<br>Planning Problem, languages of Planning, Planning with State Space Search, Forward State Space Search, and Backward State space Search, Heuristic State Space Search, Partial Order Planning, Partial Order Planning with un-bound variables, Heuristics for POP, Planning Graphs, Planning Graphs for Heuristic estimation, GRAPHPLAN, Termination of GRAPHPLAN. |

**UNIT – V**

Acting under Uncertainty, Basic Probability notation, Conditional Probability, Axioms of Probability, Inference using Full Joint Distribution, Independence, Bayes' Rule and its uses, Combining evidence, Probabilistic Reasoning.

**References / Text Books:**


- Artificial Intelligence, A Modern Approach. By Stuart Russell and Peter Norwig
- Learn Prolog Now! By Patrick Blackburn, Johan Bos & Kristina Striegnitz

| Digital Image Processing | |
|---|---|
| **Paper Code** | **PHD E11** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I** |

**Introduction And Digital Image Fundamentals**

The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing, Elements of Digital Image Processing Systems, Image Sampling and Quantization, Some basic relationships like Neighbours, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations.

**UNIT- II**

Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters, Combining Spatial Enhancement Methods. Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters, Homomorphic Filtering.

**UNIT- III**

**Image Restoration:**

A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Pereodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invarient Dedradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained

Least Square Filtering, Geometric Mean Filter, Geometric Transformations.

**UNIT- IV**

**Image Compression**

Coding, Interpixel and Psychovisual Redundancy, Image Compression models, Elements of Information Theory, Error free comparison, Lossy compression, Image compression standards

**Image Segmentation:** Detection of Discontinuities, Edge linking and boundary detection, Thresholding, Region Oriented Segmentation, Motion based segmentation.

**UNIT – V**

**Representation and Description**

Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms.

**Object Recognition:** Patterns and Pattern Classes Decision-Theoretic Methods, Structural Methods

**References / Text Books:**

**TEXT BOOKS:**


1. Rafael C. Conzalez & Richard E. Woods, "Digital Image Processing".
2. A.K. Jain, "Fundamental of Digital Image Processing", PHI. 2003


**REFERENCES:**


1. Rosefield Kak, "Digital Picture Processing", 1999
2. W.K. Pratt, "Digital Image Processing", 2000


**Computer Usage / Software Requires:**

| Deep Learning | |
|---|---|
| **Paper Code** | **PHD E12** |
| **Course Credits** | **4** |
| **Lectures / week** | **3** |
| **Tutorial / week** | **1** |
| **Course Description** | **UNIT – I**<br>**INTRODUCTION TO DEEP LEARNING**<br>Learning and its types, Supervised, Unsupervised, Reinforced Learning, Simple Neuron, Linear separability, XOR Problem, Artificial Neural Networks, Architectures of ANNs, Review of Error Back propagation algorithm, Need of Deep Neural Networks<br>**UNIT- II**<br>**LINEAR ALGEBRA & ML BASICS**<br>Vector, scalar, Matrix & Tensor, Rank & Inverse of a Matrix, Eigen decomposition of a Matrix, Orthogonality of Matrices, Gram-Schmidt Orthogonalization process, Singular Value decomposition, Principal Component Analysis, Moore-Penrose pseudo inverse.<br>Underfitting, Overfitting, Regularization L1 & L2, Early Stopping, Dropouts.<br>**UNIT- III**<br>**CONVOLUTIONAL NEURAL NETWORKS**<br>Introduction to Convolutional neural networks, Convolutions & Strides, Pooling, Zero Padding, Convolution Arithmetic, CNN architectures: LeNet-5, AlexNet, ZFNet, C3D, GoogLeNet, ResNet, MobileNet, Optimizers for CNN, Network weight initialization techniques.<br>**UNIT- IV**<br>**SEQUENCE MODELING**<br>Introduction to Recurrent Neural Networks (RNNs), Encoder-Decoder Sequence to Sequence Architecture, Deep RNNs, |

Long Short Term Memory (LSTM) networks, Bi-directional LSTM (Bi-LSTM).

**UNIT – V**

**DEEP LEARNING RESEARCH & APPLICATIONS:**

Autoencoders and their types, Deep Generative Models, Attention mechanism based networks, Applications of Deep networks in Computer Vision, Speech Processing and NLP

**References / Text Books:**

- Ian Goodfellow, Youshua Bengio and Aaron Courville, "Deep Learning", MIT Press.
- Simon Haykin, “A comprehensive foundation to Neural Networks” PHI.

**Computer Usage / Software Requires:**

- Java