CENTRAL INSTITUTE OF TECHNOLOGY KOKRAJHAR

(Deemed to be University, MHRD, Govt. of India)

BODOLAND TERRITORIAL AREA DISTRICTS :: KOKRAJHAR :: ASSAM :: 783370

Website: www.cit.ac.in

Department of Computer Science and Engineering

M.Tech. Programme

Total Credit Points Requirements: 130

Total Credit Hours Requirements: 95

Total Number of Semesters: 4

CURRICULUM BROCHURE

Curricula of courses running since the academic year 2019-20

1st YEAR: 1st SEMESTER (JULY-DEC)

1st Semester:								
	Code	Subjects	Contacts (periods per week)				Credit hours	Credit points
			L	T	P	Total		
1.	PCSE101	Mathematical Foundation in Computer Science	3	1	0	4	4	8
2.	PCSE102	Algorithms and Algorithmic Complexity	3	1	0	4	4	8
3.	PCSE103	Advanced DBMS	3	1	0	4	4	8
4.	PCSE11*	Elective-I	3	0	0	3	3	6
5.	PCSE172	Advanced Algorithms Lab	0	0	3	3	3	3
6.	PCSE173	Advanced DBMS Lab	0	0	3	3	3	3
7.	PCSE191	Seminar	0	0	2	2	2	2
Total							23	38

Total Credits of 1st Semester: 38

1st YEAR: 2nd SEMESTER (JAN-JUNE)

2nd Semester:								
	Code	**Subjects**	**Contacts (periods per week)**				**Credit hours**	**Credit points**
			L	**T**	**P**	**Total**		
1.	**PCSE201**	**Advanced Computer Network**	**3**	**1**	**0**	**4**	**4**	**8**
2.	**PCSE202**	**Advanced Operating System**	**3**	**1**	**0**	**4**	**4**	**8**
3.	**PCSE21***	**Elective -II**	**3**	**0**	**0**	**3**	**3**	**6**
4.	**PCSE21***	**Elective -III**	**3**	**0**	**0**	**3**	**3**	**6**
5.	**PCSE271**	**Advanced Computer Network Lab**	**0**	**0**	**3**	**3**	**3**	**3**
6.	**PCSE272**	**Advanced Operating System Lab**	**0**	**0**	**3**	**3**	**3**	**3**
7.	**PCSE291**	**Seminar**	**0**	**0**	**2**	**2**	**2**	**2**

Total					**22**	**36**

Total Credits of 2nd Semester: 36

2nd YEAR: 3rd SEMESTER (JULY-DEC)

3rd Semester:								
	Code	**Subjects**	**Contacts (periods per week)**				**Credit hours**	**Credit points**
			L	**T**	**P**	**Total**		
1.	**PCSE31***	**Elective-IV**	**3**	**0**	**0**	**3**	**3**	**6**
2.	**PCSE31***	**Elective-V**	**3**	**0**	**0**	**3**	**3**	**6**
3.	**PCSE391**	**Project Phase - I**	**0**	**0**	**16**	**16**	**16**	**16**
4.	**PCSE392**	**Seminar**	**0**	**0**	**0**	**2**	**2**	**2**

Total					**24**	**30**

Total Credits of 3rd Semester: 30

2nd YEAR: 4th SEMESTER (JAN-JUNE)

4th Semester:								
	Code	**Subjects**	**Contacts (periods per week)**				**Credit hours**	**Credit points**
			L	**T**	**P**	**Total**		
1.	**PCSE491**	**Project Phase - II**	**0**	**0**	**26**	**26**	**26**	**26**
Total							**26**	**26**

Total Credits of 4th Semester: 26

Important note:

§ 'L' - 2 credit points for 1 credit hours

§ 'T' - 2 credit points for 1 credit hours

§ 'P' - 1 credit point for 1 credit hour

§ 'Seminar' - 1 credit point for 1 credit hour

§ 'Project' - 1 credit point for 1 credit hour

Electives for M.Tech (CSE)

Odd Semester Elective courses list:

1st Semester:

1. PCSE111– Artificial Intelligence.
2. PCSE112– Automata Theory
3. PCSE113– Distributed Systems.
4. PCSE114– Embedded Systems and Real Time System.
5. PCSE115– Mobile and Pervasive Computing.
6. PCSE116– Natural Language Processing.
7. PCSE117– Object Oriented Programming and Design.
8. PCSE118– Remote Sensing and Digital Image Processing.

3rd Semester:

1. PCSE311– Advanced Cryptography and Information Security
2. PCSE312– Advanced Digital Image Processing.
3. PCSE313– Big Data Analytics.
4. PCSE314– Computational Biology.
5. PCSE315– High Performance Computing.
6. PCSE316– Information Retrieval.
7. PCSE317– Ubiquitous Computing.
8. PCSE318 - Software Defined Networking

Even Semester Elective courses list:

2nd Semester:

1. PCSE211– Cloud Computing.
2. PCSE212– Data Mining and Data Warehousing.
3. PCSE213– Human Computer Interaction.
4. PCSE214– Machine Learning.
5. PCSE215– Optimization Method.
6. PCSE216– Robotics and Computer Vision.
7. PCSE217– Soft Computing.
8. PCSE218 - Image Processing and Pattern Recognition

SEMESTER-I

Paper Code: PCSE101 **Credit: 8**
Paper Name: Mathematical Foundation of Computer Science **L-T-P: 3-1-0**
Total Contact Hours: 48

UNIT -I: Mathematical Logic: **Contact Hours: 8**

Propositional Calculus: Statements and Notations, Connectives, Well-Formed Formulas, Truth Tables, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications, Normal Forms, Theory of Inference for Statement Calculus, Consistency of Premises, Indirect Method of Proof. Predicate Calculus: Predicate Logic, Statement Functions, Variables and Quantifiers, Free and Bound Variables, Inference Theory for Predicate Calculus.

UNIT -II: Set Theory: **Contact Hours: 8**

Introduction, Operations on Binary Sets, Principle of Inclusion and Exclusion, Relations: Properties of Binary Relations, Relation Matrix and Digraph, Operations on Relations, Partition and Covering, Transitive Closure, Equivalence, Compatibility and Partial Ordering Relations, Hasse Diagrams, Functions: Bijective Functions, Composition of Functions, Inverse Functions, Permutation Functions, Recursive Functions, Lattice and its Properties.

UNIT- III: Algebraic Structures and Number Theory: **Contact Hours: 8**

Algebraic Structures: Algebraic Systems, Examples, General Properties, Semi Groups and Monoids, Homomorphism of Semi Groups and Monoids, Group, Subgroup, Abelian Group, Homomorphism, Isomorphism, Number Theory: Properties of Integers, Division Theorem, The Greatest Common Divisor, Euclidean Algorithm, Least Common Multiple, Testing for Prime Numbers, The Fundamental Theorem of Arithmetic, Modular

Arithmetic (Fermat‘s Theorem and Euler‘s Theorem)

UNIT -IV: Combinatorics: **Contact Hours: 8**

Basic of Counting, Permutations, Permutations with Repetitions, Circular Permutations, Restricted Permutations, Combinations, Restricted Combinations, Generating Functions of Permutations and Combinations, Binomial and Multinomial Coefficients, Binomial and Multinomial Theorems, The Principles of Inclusion Exclusion, Pigeonhole Principle and its Application.

UNIT -V: Recurrence Relations: **Contact Hours: 8**

Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots, Solving Inhomogeneous Recurrence Relations

UNIT -VI: Graph Theory: **Contact Hours: 8**

Basic Concepts of Graphs, Sub graphs, Matrix Representation of Graphs: Adjacency Matrices, Incidence Matrices, Isomorphic Graphs, Paths and Circuits, Eulerian and Hamiltonian Graphs, Multigraphs, Planar Graphs, Euler‘s Formula, Graph Colouring and Covering, Chromatic Number, Spanning Trees, Algorithms for Spanning Trees (Problems Only and Theorems without Proofs).

Text & Reference Books:

1. Lawvere and Bosebrugh, Sets for Mathematics, Cambridge.

2. Sheldon Axler, Linear Algebra Done Right, Springer
3. Michael Artin, Algebra, Prentice-Hall India.
4. RP Stanley. Enumerative Combinatorics, Cambridge.
5. I Anderson, Combinatorics of Finite Sets, Oxford Science Publications.
6. B. Bollobas, Combinatorics, Cambridge.
7. JH van Lint and RM Wilson, A course in Combinatorics, Cambridge.
8. S Jukna. Extremal Combinatorics. Springer.

Paper Code: PCSE102 **Credit: 8**
Paper Name: Algorithms and Algorithmic Complexity **L-T-P: 3-1-0**
Total Contact Hours: 55

UNIT -I: Review **Contact Hours: 7**

Fundamentals of Algorithmic: Classification of Problems, Complexity, Asymptotic Notations, Amortized analysis

Unit-II Recurrences: **Contact Hours: 8**

Master Theorem Probabilistic Analysis: Sort, Search, Random Binary Search trees, Red-black trees, Priority Queues - Binary heaps, Binomial heaps, Bipartite Matching, Common Subsequence Problem, Flow Networks, Ford-Fulkerson Method, Knuth-Morris-Pratt Algorithm.

Unit-III Algorithm design techniques: **Contact Hours: 8**

Divide and conquer, Dynamic programming, Greedy method

Unit-IV Data compression algorithms: **Contact Hours: 8**

Huffman compression, Lempel-Ziv compression

Unit-V Approximation Algorithms: **Contact Hours: 8**

Concept, Design, Applications. Inapproximability.

Unit-VI Number-Theoretic Algorithms: **Contact Hours: 8**

RSA data encryption, Primality testing

Unit-VII NP completeness: **Contact Hours: 8**

Polynomial-time reductions, Cooke's theorem

Text & Reference Books:

1. Introduction to Algorithms - T. H. Cormen, et al. (PHI, 1990)
2. Algorithms for Hard Problems - J. Hromkovic (Springer)
3. Anany V. Levitin, Introduction to the Design and Analysis of Algorithms, Addison Wesley

Paper Code: PCSE103 **Credit: 8**
Paper Name: Advanced DBMS **L-T-P: 3-1-0**
Total Contact Hours: 42

UNIT -I **Contact Hours: 8**

Formal review of relational database and FDs Implication, Closure, its correctness

UNIT -II **Contact Hours: 8**

3NF and BCNF, Decomposition and synthesis approaches, Review of SQL99, Basics of query processing, external sorting, file scans

UNIT -III **Contact Hours: 9**

Processing of joins, materialized vs. pipelined processing, query transformation rules, DB transactions, ACID properties, interleaved executions, schedules, serialisability

UNIT -IV **Contact Hours: 9**

Correctness of interleaved execution, Locking and management of locks, 2PL, deadlocks, multiple level granularity, CC on B+ trees, Optimistic CC

UNIT -V **Contact Hours: 8**

T/O based techniques, Multiversion approaches, Comparison of CC methods, dynamic databases, Failure classification, recovery algorithm, XML and relational databases.

Text & Reference Books:

1. R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004
2. A. Silberschatz, H. Korth, S. Sudarshan, Database system concepts, 5/e, McGraw Hill, 2008.
3. K. V. Iyer, Lecture notes available as PDF file for classroom use.

Paper Code: PCSE172 **Credit: 3**

Paper Name: Advanced Algorithms Lab **L-T-P: 0-0-3**
Total Contact Hours: 27

Experiment 1

Fundamentals of Algorithm-Notions of Algorithms, Algorithm Paradigms

Developing algorithms on basic and fundamental problems.

1. To solve problems based on basic algorithms like searching, sorting, etc.
2. To solve problems using basic data structures such as array, linked list, stack, queue, tree, etc.

and write programs in any language.

Experiment 2

Asymptotic and Amortized Analysis-Time and space Complexity Analysis, Asymptotic Notations, Practical Complexities.

Develop algorithms for a problem which are efficient in terms of time and space and compare the performances of two algorithms by writing programs in any language

Design, develop and run program in any language to solve the string matching problem using naïve approach and the KMP algorithm and compare their performances.

Experiment 3

Dynamic Programming

Use the concept of dynamic programming to solve the problem of matrix chain multiplication and implement the matrix chain multiplication problem in any language.

Experiment 4

Greedy Methods

Use the greedy concept to

1. Solve the optimal binary search tree problem
2. Find the minimal spanning tree in a graph using Prim's /Kruskal's algorithm.

Experiment 5

Data Compression

1. Implement the file or code compression using Huffman‟s algorithm.
2. Implement the file or code compression using Lempel-Ziv compression

Experiment 6

Approximation algorithms

Use the concept of Approximation Algorithms to solve the travelling salesman problem (TSP) and implement it in any language.

Experiment 7

Number-Theoretic Algorithms

Design, develop and run a program in any language to implement a Miller Rabin / Monte Carlo algorithm to test the primality of a given integer and determine its performance.

Write a program in any language for a simple RSA algorithm to encrypt and decrypt the data.

Text & Reference Books:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press/McGraw-Hill, 2001.
2. Sanjoy Dasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, Tata McGraw-Hill, 2008.
3. Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson, 2005.
4. Michael T Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006.
5. Udi Manber, Algorithms – A Creative Approach, Addison-Wesley, Reading, MA, 1989.
6. Harry R. Lewis and Larry Denenberg, Data Structures and Their Algorithms, Harper Collins, 1997.
7. Robert Sedgewick and Kevin Wayne, Algorithms, fourth edition, Addison Wesley, 2011.

Paper Code: PCSE173 **Credit: 3**
Paper Name: Advanced DBMS Lab **L-T-P: 0-0-3**
Total Contact Hours: 36

Experiment 1 : Basic SQL

Experiment 2: Intermediate SQL

Experiment 3: Advanced SQL

Experiment 4: ER Modeling

Experiment 5: Database Design and Normalization

Experiment 6: Accessing Databases from Programs using JDBC

Experiment 7: Building Web Applications using PHP & MySQL

Experiment 8: Indexing and Query Processing

Experiment 9: Query Evaluation Plans

Experiment 10: Concurrency and Transactions

Experiment 11: Big Data Analytics using Hadoop

Text & Reference Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision wesley, 2007

ELECTIVES SEMESTER-I

Paper Code: PCSE111 **Credit: 6**
Paper Name: Artificial Intelligence **L-T-P: 3-0-0**
Total Contact Hours: 38

Unit-I Introduction: **Contact Hours: 3**

AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

Unit-II Searching: **Contact Hours: 8**

Searching for solutions, uninformed search strategies – Breadth first search, depth first search, Depth limited search, Iterative deepening depth first search bi-direction search - comparison. Search with partial information (Heuristic search) Greedy best first search, A* search, Memory bounded heuristic search, Heuristic functions. Local search Algorithms, Hill climbing, simulated, annealing search, local beam search, genetic algorithms.

Unit-III Game Playing: **Contact Hours: 5**

Adversarial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.

Unit-IV Knowledge Representation & Reasons logical Agents: **Contact Hours: 9**

Knowledge – Based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in propositional logic, Resolution, Forward & Backward Chaining.

First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts, forward chaining, Backward chaining, Resolution

Unit-V Planning: **Contact Hours: 5**

Classical planning problem, Language of planning problems, Expressiveness and extension, planning with state – space search, Forward states spare search, Backward states space search, Heuristics for state space search. Planning search, planning with state space search, partial order planning Graphs.

Unit-VI Learning: **Contact Hours: 4**

Forms of learning, Induction learning, Learning Decision Tree, Statistical learning methods, learning with complex data, learning with Hidden variables – The EM Algorithm, Instance Based learning, Neural Networks.

Unit-VI Advanced Topics: **Contact Hours: 4**

Introduction to Natural language processing and expert systems.

Text & Reference Books:

3. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/Pearson Education.
4. Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition.
5. Artificial Intelligence , 2nd Edition, E.Rich and K.Knight (TMH).
6. Artificial Intelligence and Expert Systems – Patterson PHI.
7. Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.

8. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.

Paper Code: PCSE112 **Credit: 6**
Paper Name: Automata Theory **L-T-P: 3-0-0**
Total Contact Hours: 35

Unit-I **Contact Hours: 7**

Automata and Languages: finite automata and regular expressions, pushdown automata and context-free grammars

Unit-II **Contact Hours: 7**

Pumping lemmas and closure properties of regular and context-free languages, non-context-free languages.

Unit-III **Contact Hours: 7**

Computability theory: the Church-Turing thesis, Hilbert's problem, decidability, halting problem, reducibility.

Unit-IV **Contact Hours: 7**

Complexity theory: time and space complexity, Classes P, NP, NP-complete, PSPACE, and PSPACE-complete

U**nit-V** **Contact Hours: 7**

Intractability: hierarchy theorem, Relativization, Circuit complexity

Text & Reference Books:

1. Introduction to Automata Theory Languages and Computation. Hopcroft H.E. and Ullman J. D.Pearson Education
2. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
3. Introduction to languages and the Theory of Computation ,John C Martin, TMH
4. Elements of Theory of Computation, Lewis H.P. &Papadimition C.H. Pearson.
5. Theory of Computer Science – Automata languages and computation -Mishra and Chandrashekaran, 2nd edition, PHI
6. Introduction to Theory of Computation –Sipser 2nd edition Thomson

Paper Code: PCSE113 **Credit: 6**
Paper Name: Distributed System **L-T-P: 3-0-0**
Total Contact Hours: 38

Unit-I Introduction: **Contact Hours: 5**

Introduction to Distributed Systems: Basic assumptions of Distributed Systems; Interaction Model; Failure Model.

Unit-II Architectures for Distributed Systems: **Contact Hours: 5**

Client - server architecture; Master - slave architecture; Master - slave architecture with multiple masters; Service oriented architecture. Each architecture is analyzed w.r.t. their respective interaction and failure model.

Unit-III Technologies for Distributed Systems: **Contact Hours: 2**

Sockets; RPC; RMI; Web Service.

Unit-IV Physical Clock synchronization: **Contact Hours: 3**

Internal and external synchronization of physical clocks; Christian's algorithm; Berkeley algorithm.

Unit-V Logical Clocks: **Contact Hours: 3**

Events; the 'happened before' relation; Lamport clock; Vector clock (with proof of correctness).

Unit-VI Global State: **Contact Hours: 4**

Need for obtaining global state; expressing global state as a history of events; cuts; consistent and in-consistent cuts; Chandy-Lamport snapshot algorithm.

Unit-VII Traversal Algorithms: **Contact Hours: 4**

Need for traversal algorithms; initiators and non-initiators; traversal algorithms for the following topologies (along with analysis of complexity): ring, tree, mesh, hypercube.

Unit-VIII ElectionAlgorithms: **Contact Hours: 5**

Need for election algorithms; election algorithms for the following topologies (along with complexity analysis and proof of correctness): ring, tree, mesh, hypercube.

Unit-IX Multicasting: **Contact Hours: 5**

Basic multicasting; ensuring the 'all or none' property; receipt and delivery of multicast messages; hold-back queue; FIFO ordered multicasting; causal ordered multicasting; total ordered multicasting.

Unit-X Introduction to Distributed Transaction Processing: **Contact Hours: 2**

Pessimistic and optimistic approaches to transaction processing.

Text & Reference Books:

1. Distributed Systems: Principles and Paradigms, Andrew Tanenbaum and Maarten van Steen, Prentice Hall.
2. Principles of Computer System Design. Jerome Saltzer and M. Frans Kaashoek, Morgan Kaufmann
3. Advanced Programming in the UNIX Environment. W. Richard Stevens The C++ Programming Language. Bjarne Stroustrup. Addison Wesley

4. UNIX Network Programming. Volume 1: Networking APIs: Sockets and XTI. W. Richard Stevens

Paper Code: PCSE114 **Credit: 6**
Paper Name: Embedded Systems and Real Time System. **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I Introduction to Embedded Systems: **Contact Hours: 5**

Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

Unit-II Typical Embedded System: **Contact Hours: 5**

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

Unit-III Real Time Systems and Resources: **Contact Hours: 6**

Real-Time Systems and Resources: Brief history of Real Time Systems. Processing with Real Time Scheduling: Scheduler Classes, Preemptive Fixed Priority Scheduling Policies with timing diagrams, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies, Worst case execution time, Deadlock and livelock.

Unit-IV Real Time Operating Systems: **Contact Hours: 8**

Operating System basics, The Kernel and its subsystems, Kernel Space and User Space, Kernel Architecture, Types of operating system, Task, process and Threads, Multi-Processing and Multitasking, Types of multitasking, Task Scheduling, Task states, Non-Preemptive scheduling, Preemptive Scheduling, Round Robin Scheduling, Idle Task, Task Communication, Task Synchronization, Thread Safe Reentrant Functions.

Unit-V Embedded Firmware Design, development and Free RTOS: **Contact Hours: 8**

Embedded Firmware Design Approaches, Super-loop based approach, Embedded Operating System based approach, Programming in Embedded C, Integrated development environment (IDE), Overview of IDEs for Embedded System Development. Introduction to FreeRTOS, multitasking on an LPC17xx Cortex-M3 Microcontroller, LPC17xx Port of FreeRTOS, Resources Used by FreeRTOS, Task Management, Task Functions, Task Priorities, Idle task and task hook function, Creation and Deletion of tasks.

Unit VI : Embedded System design with Free RTOS **Contact Hours: 8**

Queue Management, Characteristics of a Queue, Working with Large Data, Interrupt Management, Queues within an Interrupt Service Routine, Critical Sections and Suspending the Scheduler, Resource Management, Memory Management.

Text & Reference Books:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
2. Embedded Systems - Raj Kamal, TMH.
3. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
4. An Embedded Software Primer - David E. Simon, Pearson Education.
5. C.M. Krishna, Kang G. Shin, "Real Time Systems", McGraw - Hill International Editions, 1997.
6. Albert M. K. Cheng , “Real-time systems: scheduling, analysis, and verification” Wiley

7. Sam Siewert , “Real-Time Embedded Systems And Components”.
8. “Using the FreeRTOS Real Time Kernel” From FreeRTOS.

Paper Code: PCSE115 **Credit: 6**
Paper Name: Mobile and Pervasive Computing **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I Introduction to Mobile Computing: **Contact Hours: 5**

History – Wireless communications: GSM – DECT – TETRA – UMTS – IMT – 2000 – Bluetooth, WiFi, WiMAX, 3G ,WATM.- Mobile IP protocols -WAP push architecture-Wml scripts and applications. Data networks – SMS – GPRS – EDGE – Hybrid Wireless100 Networks – ATM – Wireless ATM.

Unit-II Overview of LTE/4G System: **Contact Hours: 5**

Introduction. LTE-A System Architecture. LTE RAN. OFDM Air Interface. Evolved Packet Core. LTE Requirements. LTE-Advanced. LTE-A in Release. OFDMA – Introduction. OFDM Principles. LTE Uplink—SC-FDMA. Summary of OFDMA.

Unit-III Overview of 5G System: **Contact Hours: 6**

Introduction - Evolution toward 5G Networks - Challenges in 5G Networks - Emerging Trends in 5G Networks - LTE/LTE-A 4G and Beyond Technology - MIMO Enhancements: 3D - Beamforming, Full-Dimension - MIMO, and Massive MIMO - Millimeter-Wave Communication Technology - Channel State Information Feedback Concepts of 3GPP LTE - Channel State Information Feedback Concepts for 5G.

Unit-IV Heterogeneous Network: A 5G Perspective: **Contact Hours: 8**

Introduction - OFDM and OFDMA Techniques in HetNets - Dense HetNets - Components of Multi-Cellular Heterogeneous Networks - Radio Resource Management Schemes for HetNets - Energy-Efficient Schemes for HetNets - Software-Defined Cellular Networks - Mobile Cloud Computing in Multi-Cellular HetNets - Multi-Tier Architecture of Cloud RAN for Efficient Data Management in HetNets - Internet of Things in LTE/HetNets - Inband/Outband Vehicular Communication in Small Cell HetNets.

Unit-V Introduction to Pervasive Computing: **Contact Hours: 8**

Concept of Pervasive Computing, Modeling the Key Ubiquitous/Pervasive Computing Properties, Mobile Adaptive Computing, Mobility Management and Caching. Smart Environment : CPI and CCI, Smart Devices : Application and Requirements , Ubiquitous Networks of Devices: CCI, Human to Human Interaction (HHI) Applications.

Unit-VI Management of Smart Devices: **Contact Hours: 8**

Managing Smart Devices in Virtual Environments, Process and Application Management, Network Oriented Management, Monitoring and Accounting, Configuration Management, Fault Management, Performance Management, Service Oriented Computer Management, Managing Smart Devices in Physical Environments.

Text & Reference Books:

1. Jochen H. Schller, ―Mobile Communications‖, Second Edition, Pearson Education, New Delhi, 2007.
2. Juha Korhonen, ―Introduction to 4G Mobile Communications‖ , Artech House Publishers, 2014.
3. M. Bala Krishna, Jaime Lloret Mauri, ―Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks‖, CRC 2016.

4. Prasant Kumar Pattnaik, Rajib Mall, ―Fundamentals of Mobile Computing‖, PHI Learning Pvt. Ltd, New Delhi – 2012.
5. William.C.Y.Lee,―Mobile Cellular Telecommunications-Analog and Digital Systems‖, Second Edition,Tata Mc Graw Hill Edition ,2006.
6. Stefan Poslad, Ubiquitous Computing, Smart devices, environment and interaction, Wiley.
7. Frank Adelstein, Sandeep Gupta, Golden Richard III, Loren Schwiebert, Fundamentals of Mobile and Pervasive Computing, Tata McGraw Hills

Paper Code: PCSE116 **Credit: 6**
Paper Name: Natural Language Processing **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I Introduction: **Contact Hours: 5**

Human languages, models, ambiguity, processing paradigms; Phases in natural language processing, applications. Text representation in computers, encoding schemes.

Unit-II Linguistics Resources **Contact Hours: 5**

Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc, Resource management with XML, Management of linguistic data with the help of GATE, NLTK. Regular expressions, Finite State Automata, word recognition, lexicon.

Unit-III Morphology and Part of Speech Tagging: **Contact Hours: 6**

Linguistic essentials, Lexical syntax, Morphology and Finite State Transducers, Finite State Transducer. N-grams, smoothing, entropy, Part of speech Tagging, Rule-Based Part of Speech Tagging, Markov Models, Hidden Markov Models, transformation based Models, Maximum Entropy Models, Conditional Random Fields.

Unit-IV Natural Language Grammars: **Contact Hours: 8**

A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax.

Unit-V Parsing and Semantic: **Contact Hours: 8**

Unification, probabilistic parsing, TreeBank, Features and Unification, Statistical parsing and probabilistic CFGs (PCFGs), Lexicalized PCFGs. Semantics- Meaning representation, semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional restriction, machine learning approaches, and dictionary based approaches. Discourse- Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure.

Unit-VI Applications: **Contact Hours: 8**

Spell-checking, Summarization Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries. Machine Translation– Overview. Basic issues in MT-Statistical translation-word alignment, phrase-based translation.

Text & Reference Books:

1. Daniel Jurafsky and James H. Martin “Speech and Language Processing (2nd Edition)”, Prentice Hall; 2 edition, 2008.
2. Christopher D. Manning and Hinrich Schuetze “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
3. Steven Bird, Ewan Klein and Edward Loper “Natural Language Processing with Python”, O’Reilly Media; 1 edition, 2009.
4. Pierre M. Nugues, An Introduction to Language Processing with Perl and Prolog: An Outline of Theories, Implementation, and Application with Special Consideration of English, French, and German (Cognitive Technologies) Softcover reprint, 2010.
5. James Allen, Natural Language Understanding, Addison Wesley; 2 edition 1994.

Paper Code: PCSE117 **Credit: 6**
Paper Name: Object Oriented Programming and Design **L-T-P: 3-0-0**
Total Contact Hours: 35

Unit-I Introduction to UML: **Contact Hours: 5**

Importance of modeling, principles of modeling, object oriented modeling, conceptual model of the UML, Architecture, Software Development Life Cycle.

Unit-II Basic Structural Modeling: **Contact Hours: 5**

Classes, Relationships, common Mechanisms, and diagrams. Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages.

Unit-III Class & Object Diagrams: **Contact Hours: 5**

Terms, concepts, modeling techniques for Class & Object Diagrams.

Unit-IV Basic Behavioral Modeling-I: **Contact Hours: 5**

Interactions, Interaction diagrams.

Unit-V Basic Behavioral Modeling-II: **Contact Hours: 5**

Use cases, Use case Diagrams, Activity Diagrams.

Unit-VI Advanced Behavioral Modeling: **Contact Hours: 5**

Events and signals, state machines, processes and Threads, time and space, state chart diagrams.

Unit-VII Architectural Modeling: **Contact Hours: 5**

Component, Deployment, Component diagrams and Deployment diagrams.
Case Study: The Unified Library application.

Text & Reference Books:

1. Grady Booch, James Rumbaugh, Ivar Jacobson : The Unified Modeling Language User Guide, Pearson Education.
2. Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado: UML 2 Toolkit, WILEY-Dreamtech India Pvt. Ltd.
3. Meilir Page-Jones: Fundamentals of Object Oriented Design in UML, Pearson Education.
4. Pascal Roques: Modeling Software Systems Using UML2, WILEY-Dreamtech India Pvt. Ltd.
5. Atul Kahate: Object Oriented Analysis & Design, The McGraw-Hill Companies.
6. Mark Priestley: Practical Object-Oriented Design with UML,TATA McGrawHill
7. Appling UML and Patterns: An introduction to Object – Oriented Analysis and Design and Unified Process, Craig Larman, Pearson Education.

Paper Code: PCSE118 **Credit: 6**
Paper Name: Remote Sensing and Digital Image Processing **L-T-P: 3-0-0**
Total Contact Hours: 42

Unit-I **Contact Hours: 4**

History of Remote Sensing, Remote sensing components, Sources of Energy, EMS and Radiation, Black body and associated laws Interaction of EMR with Atmosphere—Scattering, Refraction, Absorption, Transmission, Atmospheric windows, Interaction of EMR with Earth Surface—Spectral reflectance curves, Radiation Calculation.

Unit-II **Contact Hours: 6**

Orbital movement and Earth coverage. Sun synchronous and Geosynchronous satellites, Active and passive sensors, PAN, Multi High resolution and Hyper spectral Sensors, Thermal and Microwave sensors, Sensors characteristics, Indian Remote Sensing Satellite Programme, Other satellites.

Unit-III **Contact Hours: 5**

Image compression, Pixel and sub-pixel level target detection and classification, Data fusion methods and applications.

Unit-IV **Contact Hours: 5**

DEM generation from stereo-satellite images, CARTOSAT DEM, SRTM DEM, ASTER DEM, Parameter extraction.

Unit-V **Contact Hours: 8**

Empirical modelling of biophysical parameters from multi and hyperspectral remote sensing data, 3D visualisation of data.

Unit-VI **Contact Hours: 8**

ANN, Fuzzy Logic, Object based classification from satellite images

Unit-VII **Contact Hours: 6**

Applications of multi and hyperspectral remote sensing data in water resources, forestry, earth sciences, resource management and planning, military target detection.

Text & Reference Books:

1. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, “Remote Sensing and Image Interpretation”, 7th Edition, Wiley, 2015.
2. Chen, C.H., “Information Processing for Remote Sensing”, World Scientific. 1999.
3. Landgrebe, D., “Signal Theory Methods in Multi-spectral Remote Sensing”, John Wiley. 2003.
4. Richards, John A. and Xiuping, Jia., “Remote Sensing Digital Image Analysis : An Introduction”, Springer-Verlag. 1999.

SEMESTER-II

Paper Code: PCSE201 **Credit: 8**
Paper Name: Advanced Computer Network **L-T-P: 3-1-0**
Total Contact Hours: 46

Unit I Internet Design & Architecture: **Contact Hours: 6**

Overview of network building blocks, Network architecture, layers and protocols, Internet design: Challenges and Solutions

Unit II Basic Protocols: **Contact Hours: 6**

Overview of IPv4, TCP, IPv6, ICMP, ARP, DHCP;

Unit III Routing Protocols: **Contact Hours: 8**

OSPF, RIP, BGP, Ad hoc network routing (AODV, DSR);

Unit IV Traffic Management: **Contact Hours: 6**

Congestion control principles, TCP congestion control, Traffic Engineering Principles, MPLS Routing

Unit V Software Defined Networks (SDNs): **Contact Hours: 8**

SDN Controllers, Network Programmability, Network Function Virtualization, SDN Frameworks, Use cases for traffic monitoring & classification, bandwidth scheduling and monitoring

Unit VI Wireless Networks: **Contact Hours: 6**

Wireless Networks fundamentals, Mobile IP and Micro Mobility Protocols, TCP performance in Wireless Networks

Unit VII IP Security: **Contact Hours: 6**

NAT, IPSEC, SSL

Text & Reference books :

1. Kurose James F and Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet
2. Adolfo Rodriguez, et. al, TCP/IP Tutorial and Technical Overview, IBM Redbook, available online at http://www.redbooks.ibm.com/pubs/pdfs/redbooks/gg243376.pdf, 2001.
3. Charles. M.Kozierek, TCP/IP Guide, Shroff Publishers, Mumbai, 2005.
4. Uyless Black, MPLS and Label Switching Networks, Pearson Education (LPE), 2002.

Paper Code: PCSE202 **Credit: 8**
Paper Name: Advanced Operating System **L-T-P: 3-1-0**
Total Contact Hours: 46

Unit I : **Contact Hours: 6**

Distributed systems, Issues in communication, Remote Procedure Call, Remote Method Invocation

Unit II: **Contact Hours: 6**

IPC in distributed systems, Message- and Stream-Oriented communication, Processes and threads, Code migration and distributed scheduling, Naming

Unit III: **Contact Hours: 6**

Clock Synchronization, Distributed mutual exclusion and distributed deadlocks, Distributed transaction, Consistency models, Replication, Fault tolerance, Distributed commit and failure recovery

Unit IV: **Contact Hours: 6**

Distributed file systems (NFS, AFS & coda), Security in distributed systems, Security: authentication

Unit V: **Contact Hours: 6**

Distributed middleware: CORBA Case studies: DCOM and JINI, The Google File System, OceanStore, ZFS, Hadoop, Facebook Photo Storage

Text & Reference books :

1. Andrew Tanenbaum and Maarten van Steen, *Distributed Systems Principles and Paradigms*
2. Mukesh Singhal and Niranjan Shivaratri, *Advanced Concepts in Operating Systems*
3. Tanenbaum, *Modern Operating Systems* (background)
4. Silberschatz, Galvin, Gagne, *Operating System Concepts* (background)
5. Gary Nutt, *Operating Systems: A Modern Perspective* (background)
6. Gary Nutt, *Kernel Projects for Linux* (background)
7. Kernighan, Ritchie, *The C Programming Language* (background)
8. Maxwell, *Linux Core Kernel Commentary* (background)
9. Corbet, Rubini, and Kroah-Hartman, *Linux Device Drivers*, 3rd edition (background)

Paper Code: PCSE271 **Credit: 3**
Paper Name: Advanced Computer Network Lab **L-T-P: 0-0-3**
Total Contact Hours: 36

Experiment 1: The TCP Latency and Bandwidth

This submodule introduces students to a contemporary, multithreaded, multiprocessing network stack, with a particular interest in the TCP protocol. Labs will consider both the behaviour of a single TCP connection, exploring the TCP state machine, socket-buffer interactions with flow control, and TCP congestion control. Students will use NS3/other simulators to simulate network latency and explore how TCP slow start and congestion avoidance respond to network conditions.

Experiment 2: Configuration and logging to a CISCO Router and introduction to the basic user Interfaces. Introduction to the basic router configuration and basic commands.

Experiment 3: Configuration of IP addressing for a given scenario for a given set of topologies.

Experiment 4: Configure a DHCP Server to serve contiguous IP addresses to a pool of four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automatically serve Windows and Linux OS Binaries based on client MAC address.

Experiment 5: Configure, implement and debug the following: Use open source tools for debugging and diagnostics.

ARP/RARP protocols
RIP routing protocols
BGP routing
OSPF routing protocols
Static routes (check using netstat)

Experiment 6: Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.

Experiment 7: Configure FTP Server on a Linux/Windows machine using a FTP client/SFTP client characterise file transfer rate for a cluster of small files 100k each and a video file of 700mb.Use a TFTP client and repeat the experiment.

Experiment 8: Configure a mail server for IMAP/POP protocols and write a simple SMTP client in C/C++/Java client to send and receive mails.

Text & Reference books :

1. W. R. Stevens, UNIX Network Programming, Volume 1: Networking APIs: Sockets and XTI, Prentice Hall, 1998.
2. W. R. Stevens, UNIX Network Programming, Volume 2: Interprocess Communications, Prentice Hall, 1999.

Paper Code: PCSE272 **Credit: 3**
Paper Name: Advanced Operating System Lab **L-T-P: 0-0-3**
Total Contact Hours: 36

Experiment 1: POSIX I/O Performance

The purpose of this submodule is to introduce students to the structure of a contemporary operating system kernel through tracing and profiling.

Experiment 2: Kernel Implications of IPC

This submodule introduces students to concrete implications of the UNIX process model, processes and threads in both userspace and kernel space, the hardware foundations for kernel and process isolation, system calls, and traps.

Experiment 3: Micro-Architectural Implications of IPC

Experiment 4: File I/O in terms of system calls and traps

Experiment 5: Implement Paging Technique of memory management

Experiment 6: Implement Segmentation Technique of memory management

Experiment 7: Swapping in/out mechanism

Experiment 8: Implement Threading & Synchronization Applications

Experiment 9: Implement the all page replacement algorithms a) FIFO b) LRU c) LFU

Experiment 10: Advanced CPU scheduling algorithms

Experiment 11: Write a CPU bound C program and a I/O bound C program. Compile and execute both of them. Observe the effect of their CPU share.

Text & Reference books :

1. W. R. Stevens, Advanced Programming in the UNIX Environment, Addison Wesley, 1992.
2. Raj Jain, *The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling*, Wiley - Interscience, New York, NY, USA, April 1991.
3. Robert Love: Linux Kernel Development , 3rd edition

ELECTIVES SEMESTER-II

Paper Code: PCSE211 **Credit: 6**
Paper Name: Cloud Computing **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I Introduction: **Contact Hours: 3**

Online Social Networks and Applications. Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing

Unit-II Cloud Computing Architecture: **Contact Hours: 10**

Requirements, Introduction to Cloud Computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud Computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualizations Cloud Computing Defined,

The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model

Cloud Deployment Models

Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise

Unit-III Security Issues in Cloud Computing: Contact Hours: 7

Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider |Data and Its Security.

Identity and Access Management

Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management

Unit-IV Security Management in the Cloud: Contact Hours: 9

Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS

Privacy Issues

Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations

Unit-V Audit and Compliance: Contact Hours: 7

Internal Policy Compliance, Governance, Risk and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud

Unit-VI Advanced Topics: Contact Hours: 4

Recent developments in hybrid cloud and cloud security.

Text & Reference Books:

1. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Recursive Press.
2. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, Reilly Media.

Paper Code: PCSE212 **Credit: 6**
Paper Name: Data Mining & Data Warehousing **L-T-P: 3-0-0**
Total Contact Hours: 34

Unit-I Introduction: **Contact Hours: 3**

Overview, Motivation (for Data Mining), Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data,(Binning, Clustering, Regression, Computer and Human inspection),Inconsistent Data, Data Integration and Transformation. Data Reduction:-Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation

Unit-II Concept Description: **Contact Hours: 5**

Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining, mining Single-Dimensional Boolean Association rules from Transactional Databases– Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multidimensional Association rules from Relational Databases

Unit-III Classification and Predictions: **Contact Hours: 8**

What is Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm.

Unit-IV Cluster Analysis: **Contact Hours: 10**

Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach, Neural Network approach, Outlier Analysis

Unit-V Data Warehousing: **Contact Hours: 4**

Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multidimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting.

Unit-VI Advanced Topics: **Contact Hours: 4**

Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse.

Text & Reference Books:

1. Jiawei Han, Micheline Kamber, ”Data Mining Concepts & Techniques” Elsevier

2. M.H.Dunham,”Data Mining:Introductory and Advanced Topics” Pearson Education

3. Sam Anahory, Dennis Murray, “Data Warehousing in the Real World : A Practical Guide for Building Decision Support Systems”, Pearson Education

4. Mallach,”Data Warehousing System”,McGraw –Hill

5. Arun K. Pujari “Data Mining Techniques”, Universities Press, 01-Jul-2001

Paper Code: PCSE213 **Credit: 6**
Paper Name: Human Computer Interaction **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I **Contact Hours: 7**

Human I/O channels - Memory - Reasoning and problem solving; The computer: Devices, Memory, processing and networks; Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, paradigms.

Unit-II **Contact Hours: 10**

Interactive Design basics: process, scenarios, navigation, screen design, Iteration and prototyping; HCI in software process: software life cycle, usability engineering, prototyping in practice, design rationale; Design rules: principles, standards, guidelines, rules; Evaluation Techniques, Universal Design.

Unit-III **Contact Hours: 6**

Cognitive models: Socio-organizational issues and stakeholder requirements, Communication and collaboration models, Hypertext, Multimedia and WWW.

Unit-IV **Contact Hours: 7**

Mobile Ecosystem: Platforms, Application frameworks, Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Unit-V **Contact Hours: 7**

Designing Web Interfaces: Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow, Case Studies.

Unit-VI **Contact Hours: 3**

Recent Trends: Speech Recognition and Translation, Multimodal System.

Text & Reference Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education
2. Brian Fling, "Mobile Design and Development", First Edition, OReilly Media Inc
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, OReilly

Paper Code: PCSE214 **Credit: 6**
Paper Name: Machine Learning **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I Supervised Learning (Regression/Classification) **Contact Hours: 10**

Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes;

Linear models: Linear Regression, Logistic Regression, Generalized Linear Models;

Support Vector Machines, Nonlinearity and Kernel Methods;

Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit-II Unsupervised Learning **Contact Hours: 7**

Clustering: K-means/Kernel K-means; Dimensionality Reduction: PCA and kernel PCA; Matrix Factorization and Matrix Completion; Generative Models (mixture models and latent factor models)

Unit-III **Contact Hours: 6**

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit-IV **Contact Hours: 7**

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

Unit-V **Contact Hours: 7**

Scalable Machine Learning (Online and Distributed Learning), A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference

Unit-VI **Contact Hours: 3**

Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

Text & Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Paper Code: PCSE215 **Credit: 6**
Paper Name: Optimization Method **L-T-P: 3-0-0**
Total Contact Hours: 32

Unit-I **Contact Hours: 4**

Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.

Unit-II **Contact Hours: 8**

Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.

Unit-III **Contact Hours: 5**

Transportation & Assignment Problems: Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

Unit-IV **Contact Hours: 4**

Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.

Unit-V **Contact Hours: 3**

Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines.

Unit-VI **Contact Hours: 3**

Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

Unit-VII **Contact Hours: 3**

Queuing Models: Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

Unit-VIII **Contact Hours: 2**

Replacement & Maintenance Models: Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies.

Text & Reference Books:

1. Laurence A. Wolsey (1998). Integer programming. Wiley.
2. Practical Optimization Algorithms and Engineering Applications, Andreas Antoniou.
3. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.
4. Dimitris Bertsimas; Robert Weismantel (2005). Optimization over integers. Dynamic Ideas.
5. John K. Karlof (2006). Integer programming: theory and practice.CRC Press.
6. H. Paul Williams (2009). Logic and Integer Programming. Springer.

Paper Code: PCSE216 **Credit: 6**
Paper Name: Robotics and Computer Vision **L-T-P: 3-0-0**
Total Contact Hours: 34

Unit-I **Contact Hours: 8**

The scope of industrial Robotics – Definition of an Industrial Robot – Need for Industrial Robots – Applications – Fundamentals of Robot Technology – Automation and Robotics – Robot Anatomy – Work Volume – Precision of movement End effectors – Sensors.

Unit-II **Contact Hours: 6**

Robot Programming – Methods – Interlocks textual languages – Characteristics of Robot level languages, characteristics of task level languages.

Unit-III **Contact Hours: 6**

Puma Robot Arm Control – Computed Torque Technique – Near minimum time control – Variable structure control – Non-linear decoupled feedback control – Reserved motion control – Adaptive control.

Unit-IV **Contact Hours: 4**

Robot Cell Design and control – Remote center Compliance – Safety in Robotics. Advanced Robotics, Advanced Robotics in Space – Specific features of Space Robotics systems

Unit-V **Contact Hours: 3**

Long term technical developments – Advanced Robotics in underwater operations – Robotics Technology of the future – Future applications.

Unit-VI **Contact Hours: 7**

Digital image fundamentals, digitization and 2-D parameters, types of operation; Basic tools: Convolution, Fourier transforms and statistical approaches**.**

Image analysis and processing, basic enhancement and restoration techniques, unsharp masking, noise suppression, distortion suppression, segmentation, thresholding, edge finding, binary mathematical morphology, grey-value mathematical morphology.

Text & Reference Books:

1. Barry Leatham Jones, "Elements of Industrial Robotics" Pitman Publishing, 1987.
2. Pratt, W.K., "Digital Image Processing", 2nd Ed., John Wiley & Sons, 1991
3. Mikell P. Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, "Industrial Robotics Technology, Programming And Applications", McGraw Hill Book Company, 1986.
4. Fu K.S., Gonzalez R.C and Lee C.S.G., "Robotics – Control, Sensing, Vision and Applications", McGraw Hill International Editions, 1987.
5. Bernard Hodges and Paul Hallam, "Industrial Robotics", British Library Cataloging in Publication, 1990.

Paper Code: PCSE217 **Credit: 6**
Paper Name: Soft Computing **L-T-P: 3-0-0**
Total Contact Hours: 32

Unit-I **Contact Hours: 2**

Soft Computing: Introduction, requirement, different tools and techniques, usefulness and applications.

Unit-II **Contact Hours: 6**

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.

Unit-III **Contact Hours: 8**

Artificial Neural Network: Introduction, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feedforward network, Backpropagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Recurrent Networks, RBF Network, Different Design issues, Applications.

Unit-IV **Contact Hours: 6**

Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hypothesis of building blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications.

Unit-V **Contact Hours: 4**

Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Unit-VI **Contact Hours: 6**

Hybrid Systems: Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Text & Reference Books:

1. Neural Fuzzy Systems, Chin-Teng Lin & C. S. George Lee, Prentice Hall PTR.
2. Fuzzy Sets and Fuzzy Logic, Klir & Yuan, PHI, 1997.
3. Neural Networks, S. Haykin, Pearson Education, 2ed, 2001.
4. Genetic Algorithms in Search and Optimization, and Machine Learning, D. E. Goldberg, AddisonWesley, 1989.
5. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran & G. A. V. Pai, PHI.
6. Neuro-Fuzzy and Soft Computing, Jang, Sun, & Mizutani, PHI
7. Learning and Soft Computing, V. Kecman, MIT Press, 2001.
8. Rough Sets, Z. Pawlak, Kluwer Academic Publisher, 1991.
9. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.

Paper Code: PCSE218 **Credit: 6**
Paper Name: Image Processing and Pattern Recognition **L-T-P: 3-0-0**
Total Contact Hours: 34

Unit-I Basic Concepts: **Contact Hours: 4**

Pattern Recognition Systems, Fundamental Problems in pattern recognition system design, Design concepts and Methodologies: Character recognition, Speech recognition, Finger print Recognition. Pattern Recognition Model

Unit-II Decision Functions: **Contact Hours: 4**

Linear Decision functions, Distance functions. Minimum distance and Maximum distance classification, clustering concepts, Cluster seeking algorithms, K- means Algorithms

Unit-III Baye's Classifier: **Contact Hours: 4**

Baye’s classified decision function for Baye’s classifier, Baye’s Classifier for normal patterns. Trainable pattern classifiers — deterministic approach, perception, and approach - reward—punishment concept

Unit-IV Gradient Approach: **Contact Hours: 3**

Gradient approach, Gradient Descent algorithms, LMSE Algorithms, Multi category classification.

Unit-V Trainable Pattern Classifiers **Contact Hours: 4**

Trainable pattern classifiers, statistical approach, stochastic approximation methods, Robbin Minro algorithms, increment correction algorithms, LMSE algorithms. Syntactic pattern recognition, formulation — syntax directed recognition — picture descript.

Unit-VI Digital Image Fundamentals **Contact Hours: 3**

A simple image model, Sampling and Quantization, Imaging Geometry, Digital Geometry, Image Acquisition Systems, Different types of digital images.

Unit-VII Bilevel Image Processing **Contact Hours: 3**

Basic concepts of digital distances, distance transform, medial axis transform, component labeling, thinning, morpho-logical processing, extension to grey scale morphology.

Unit-VIII Binarization and Segmentation of Grey Level Images **Contact Hours: 3**

Histogram of grey level images, Optimal thresholding using Bayesian classification, multilevel thresholding, Segmentation of grey level images, Water shade algorithm for segmenting grey level image.

Unit-IX Detection of Edges and Lines in 2d Images **Contact Hours: 3**

First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.

Unit-X Images Enhancement **Contact Hours: 3**

Point processing, Spatial Filtering, Frequency domain filtering, multi-spectral image enhancement, image restoration.

Text & Reference Books:

1. R.C.Gonzalez and R.E.Wood, Digital Image Processing, Addison Wesley.
2. J.T. Tou, R.C. Gonzalez, Pattern Recognition Principles, Addison Wesley.
3. Anil Ku Jain, Fundamentals of Digital Image Processing, PHI.
4. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Edition, Academic Press, 2009.demic Press, 2002.
5. B.Channda and D.Dutta, Digital Image Processing and Analysis, Prentice Hall.
6. Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, 2nd Edition, John Wiley, 2006.
7. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2009.

ELECTIVES SEMESTER-III

Paper Code: PCSE311 **Credit: 6**
Paper Name: Advanced Cryptography and Network Security **L-T-P: 3-0-0**
Total Contact Hours: 35

Unit-I: **Contact Hours: 4**

Principles of Security, Basic Cryptographic techniques. Classification of attacks, Virus, Worm, Trojan Horse, Spam etc.

Unit-II: **Contact Hours: 6**

Symmetric Key Cryptography: Algorithm types and modes, Cryptographic Algorithms

Unit-III: **Contact Hours: 10**

Asymmetric Key Cryptographic Algorithms, Digital Signature Digital Envelope, Message Authentication Code, Message Digest Public-Key Infrastructure (PKI)

Unit-IV: **Contact Hours: 5**

Authentication: Classifications, Mutual authentication Algorithms; Access Control

Unit-V Planning: **Contact Hours: 10**

Kerberos Security in layers and domains: IPsec, Secure Socket Layer (SSL), E-mail Security Electronic transactions; Lightweight Cryptography

Text & Reference Books:

1. Cryptography and Network Security: Principles & Practices: William Stallings, 4th Edition Pearson & Prentice Hall
2. Network Security: Kaufman, Perlman, Speciner, Pearson Education
3. Papers from the ACM and IEEE digital libraries

Paper Code: PCSE312 **Credit: 6**
Paper Name: Advanced Digital Image Processing **L-T-P: 3-0-0**
Total Contact Hours: 42

Unit-I: Various types of images **Contact Hours: 4**

PAN, Multispectral, Hyperspectral and High resolution images, Feature and intensity based image registration of images, Open Source Image Processing software and image data

Unit-II: Advanced Spatial Filtering techniques **Contact Hours: 6**

Spatial and Frequency domain (e.g., Fourier, wavelets), Texture Images

Unit-III: **Contact Hours: 5**

Image compression, Pixel and sub-pixel level target detection and classification, Data fusion methods and applications.

Unit-IV: **Contact Hours: 5**

DEM generation from stereo-satellite images, CARTOSAT DEM, SRTM DEM, ASTER DEM, Parameter extraction

Unit-V: **Contact Hours: 8**

Empirical modelling of biophysical parameters from multi and hyperspectral remote sensing data, 3D visualisation of data

Unit-VI: **Contact Hours: 8**

ANN, Fuzzy Logic, Object based classification from satellite images

Unit-VII: **Contact Hours: 6**

Applications of multi and hyperspectral remote sensing data in water resources, forestry, earth sciences, resource management and planning, military target detection

Text & Reference Books:

1. Chen, C.H., "Information Processing for Remote Sensing", World Scientific. 1999.
2. Cheng, Chein I., "Hyperspectral Imaging : Techniques for Spectral Detection and Classification", Kluwer Academic. 2003
3. Landgrebe, D., "Signal Theory Methods in Multi-spectral Remote Sensing", John Wiley. 2003
4. Richards, John A. and Xiuping, Jia., "Remote Sensing Digital Image Analysis : An Introduction", Springer-Verlag. 1999
5. Varshney, P.K. and Arora, Manoj K., "Advanced Image Processing Techniques for Hyperspectral Remote Sensing Data", Springer-Verlag. 2004

Paper Code: PCSE313 **Credit: 6**
Paper Name: Big Data Analytics **L-T-P: 3-0-0**
Total Contact Hours: 30

Unit-I: INTRODUCTION TO BIG DATA AND HADOOP **Contact Hours: 4**

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Ecosystem, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.

Unit-II: HDFS(Hadoop Distributed File System: **Contact Hours: 8**

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Sqoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit-III: Map Reduce: **Contact Hours: 5**

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Unit-IV: Hadoop EcoSystem: **Contact Hours: 9**

Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

Hbase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Big SQL: Introduction.

Unit-V: Data Analytics with R: **Contact Hours: 4**

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Text & Reference Books:

1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
5. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
6. Anand Rajaraman and Jef rey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
7. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
8. Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
9. Pete Warden, "Big Data Glossary", O'Reily, 2011.

10. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013. ArvindSathi, “BigDataAnalytics: Disruptive Technologies for Changing the Game”, MC Press, 2012
11. Paul Zikopoulos ,Dirk DeRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles , David Corigan , "Harness the Power of Big Data The IBM Big Data Platform ", Tata McGraw Hill Publications, 2012.

Paper Code: PCSE314 **Credit: 6**
Paper Name: Computational Biology **L-T-P: 3-0-0**
Total Contact Hours: 36

Unit-I: **Contact Hours: 8**

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

Unit-II: **Contact Hours: 6**

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonious trees, Additive trees, Bootstrapping.

Unit-III: **Contact Hours: 6**

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Unit-V: **Contact Hours: 8**

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

Unit-VI: **Contact Hours: 8**

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Text & Reference Books:

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004
2. Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998
3. Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 2001
4. Neural Networks: A Systematic Introduction by Raul Rojas. Springer. 1996
5. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001
6. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona,Tucson

Paper Code: PCSE315 **Credit: 6**
Paper Name: High Performance Computing **L-T-P: 3-0-0**
Total Contact Hours: 40

Unit-I: Program execution **Contact Hours: 4**

Program, Compilation, Object files, Function call and return, Address space, Data and its representation

Unit-II: Computer organization **Contact Hours: 6**

Memory, Registers, Instruction set architecture, Instruction processing

Unit-III: Pipelined processors **Contact Hours: 4**

Pipelining, Structural, data and control hazards, Impact on programming

Unit-IV: Virtual memory **Contact Hours: 4**

Use of memory by programs, Address translation, Paging

Unit-V: Cache memory **Contact Hours: 5**

Organization, impact on programming, virtual caches

Unit-VI: Operating systems **Contact Hours: 8**

Processes and system calls, Process management, Program profiling

Unit-VII: File systems **Contact Hours: 4**

Disk management, Name management, Protection

Unit-VIII: Parallel architecture **Contact Hours: 5**

Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture, Parallel programming with message passing using MPI

Text & Reference Books:

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
2. A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley.
3. R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.

Paper Code: PCSE316 **Credit: 6**
Paper Name: Information Retrieval **L-T-P: 3-0-0**
Total Contact Hours: 34

Unit-I: Introduction **Contact Hours: 6**

History of IR - Components of IR - Issues – Open source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search - Components of a Search engine - Characterizing the web

Unit-II: Boolean and vector-space retrieval models **Contact Hours: 6**

Term weighting - TF-IDF weighting - cosine similarity – Preprocessing - Inverted indices - efficient processing with sparse vectors – Language Model based IR - Probabilistic IR – Latent Semantic Indexing - Relevance feedback and query expansion.

Unit-III: Web search overview **Contact Hours: 8**

Web structure, the user, paid placement, search engine optimization/ spam. Web size measurement - search engine optimization/spam – Web Search Architectures - crawling - meta-crawlers- Focused Crawling - web indexes –- Near-duplicate detection - Index Compression – XML retrieval

Unit-IV: Link Analysis **Contact Hours: 9**

Hubs and authorities – Page Rank and HITS algorithms - Searching and Ranking – Relevance Scoring and ranking for Web – Similarity - Hadoop & Map Reduce - Evaluation - Personalized search - Collaborative filtering and content-based recommendation of documents and products – handling “invisible” Web - Snippet generation, Summarization, Question Answering, Cross-Lingual Retrieval

Unit-V: Information filtering **Contact Hours: 5**

Organization and relevance feedback – Text Mining - Text classification and clustering - Categorization algorithms: naive Bayes; decision trees; and nearest neighbor - Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).

Text & Reference Books:

1. Introduction to Information Retrieval by Christopher D. Manning
2. Natural Language Processing And Information Retrieval by Tanveer Siddiqui and U. S. Tiwary

Paper Code: PCSE317 **Credit: 6**
Paper Name: Ubiquitous Computing **L-T-P: 3-0-0**
Total Contact Hours: 37

Unit-I: Introduction **Contact Hours: 3**

Overview, Challenges, Networking Basics, NFC, Wireless LAN

Unit-II: Location in ubiquitous computing **Contact Hours: 4**

Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN Recommendation

Unit-III: Context-aware computing **Contact Hours: 4**

Context-aware computing: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture

Unit-IV: **Contact Hours: 10**

Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing, Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network, Mobile affective computing: Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI

Unit-V: Introduction to IoT **Contact Hours: 8**

Definition, trend, IOT components, IOT Applications, Cloud centric IOT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, New Protocols, QoS, QoE

Unit-VI: IoT and data analytics **Contact Hours: 8**

IOT and Data Management, Data cleaning and processing, Data storage models, Search techniques, Deep Web, Semantic sensor web, Semantic Web Data Management, Searching in IOT, Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processing

Text & Reference Books:

1. Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010
2. Papers from the ACM and IEEE digital libraries.

Paper Code: PCSE318 **Credit: 6**
Paper Name: Software Defined Networking **L-T-P: 3-0-0**
Total Contact Hours: 45

Unit-I: SDN Background and Motivation **Contact Hours: 9**

Evolving network requirements-The SDN Approach: Requirements, SDN Architecture, Characteristics of Software-Defined Networking, SDN and NFV-Related Standards: Standards-Developing Organizations, Industry Consortia, Open Development Initiatives.

Unit-II: SDN Data plane and OpenFlow **Contact Hours: 9**

SDN data plane: Data plane Functions, Data plane protocols, Openflow logical network Device: Flow table Structure, Flow Table Pipeline, The Use of Multiple Tables, Group Table- OpenFlow Protocol.

Unit-III: SDN Control Plane **Contact Hours: 9**

SDN Control Plane Architecture: Control Plane Functions, Southbound Interface, Northbound Interface, Routing, ITU-T Model- OpenDaylight-REST- Cooperation and Coordination Among Controllers.

Unit-IV: SDN Application Plane **Contact Hours: 9**

SDN Application Plane Architecture: Northbound Interface, Network Applications, User Interface- Network Services Abstraction Layer: Abstractions in SDN, Frenetic- Traffic Engineering Measurement and MonitoringSecurity- Data Center Networking- Mobility and Wireless.

Unit-V: Network Functions Virtualization **Contact Hours: 9**

Background and Motivation for NFV- Virtual Machines- NFV Concepts: Simple Example of the Use of NFV, NFV Principles, High-Level NFV Framework, NFV Benefits and Requirements- NFV Reference Architecture: NFV Management and Orchestration.

Text & Reference Books:

1. William Stallings, “Foundations of Modern Networking”, Pearson Ltd.,2016.
2. Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black,Morgan Kaufmann Publications, 2014
3. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013
4. Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.
5. Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76.
6. Online Resources https://www.coursera.org/learn/sdn