Madhyanchal Professional University, Bhopal

Program	Faculty	Branch/Specialization
Ph.D	Engineering and Technology	Computer Science Computer Science Engineering

List of Subjects

S.No	Subject Code	Name of Subject
1	CSEN019902/1	Advances in Digital Image Processing
2	CSEN019902/2	Advances in Computer Architecture
3	CSEN019902/3	Advances in computer networks
4	CSEN019902/4	Advances in Knowledge Data Discovery
5	CSEN019902/5	Advances in web Intelligence Techniques
6	CSEN019902/6	Advances in System Software and Complier Design
7	CSEN019902/7	Internet of Things (Io Ts)
8	CSEN019902/8	Machine learning (ML)
9	CSEN019902/9	Cloud and Bigdata
10	CSEN019902/10	Data Science

Madhyanchal Professional University, Bhopal

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in Digital Image Processing	CSEN19902/01

Unit-wise Content distribution

Unit	Contents
Unit-I	**Introduction:** What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System. **Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.
Unit-II	**Image Enhancement in the Spatial Domain:** Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods. **Image Enhancement in the Frequency Domain:** Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency- Domain Filters, 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, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering ,Minimum Mean Square Error (Wiener) Filtering, Constrained Least Square Filtering, Geometric Mean Filter.
Unit-IV	**Color Fundamentals:** Color Models, Pseudocolor Image Processing, Basics of Full- Color Image Processing, Color Transformations, Smoothing and Sharpening, Color Segmentation, Noise in Color Images, Color Image Compression. **Wavelets and Multiresolution Processing:** Image Pyramids, Subband coding, The Haar Transform, Multiresolution Expansions, Wavelet Transforms in one Dimension, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets. **Image Compression:** Fundamentals, Image Compression Models, Error-free (Lossless) compression, Lossy Compression.
Unit-V	**Morphological Image Processing:** Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. **Image Segmentation:** Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation. **Representation and Description:** Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Relational Descriptors.

Textbooks/References:

1. Rafael C Gonzalez and Richard E. Woods: Digital Image Processing, PHI 2nd Edition 2005
2. A. K. Jain: Fundamentals of Digital Image Processing, Pearson, 2004.
3. Scott.E.Umbaugh: Digital Image Processing and Analysis, CRC Press, 2014.
4. S.Jayaraman, S.Esakkirajan, T.Veerakumar: Digital Image Processing, McGraw Hill, 2013.

Madhyanchal Professional University, Bhopal

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in Computer Architecture	CSEN19902/02

Unit-wise Content distribution

Unit	Contents
Unit-I	**Basics of Logic Design:** Combinational logic, finite state machines. **Computer Arithmetic:** Binary number systems, floating-point numbers, operations on binary numbers, implementations, ALU design, fast adder design.
Unit-II	**Performance:** Metrics and calculations, performance equations, Amdahl's law, **Instruction Set Architecture:** Influence of Technology and Software on the instruction set. Instruction set classifications, addressing modes, instruction encoding, impact of high-level language and compilers, Microprogramming. **CPU Design And Architecture:** Instruction pipeline, stages of execution, basic CPU organization, single-cycle and multiple-cycle designs, microprogramming vs. hardwired control, interrupts.
Unit-III	**Pipelining:** Pipeline dependencies, data and control hazards, resolving hazards, forwarding, exceptions, multiple-functional-unit pipelines. **Advanced Pipelining and Instruction Level Parallelism:** Dynamic scheduling, branch prediction, superscalar issue, compiler and architectural support for Instruction Level Parallelism ILP, branch prediction and speculative execution. Advanced ILP. Out of order execution and register renaming. Advanced Superscalar Architecture.
Unit-IV	**Memory Hierarchy:** caches and cache hierarchies, cache organizations, cache performance, compiler support for cache performance, main memory organization, virtual memory, TLBs Synchronization and Sequential consistency. Cache coherency, Snoopy Protocol, MESI protocol, Relaxed Memory models.
Unit-V	VLIW / EPIC Architectures, Vector Computers, **Recent Trends:** Introduction to Multi-Core Architectures: Tiled Multi-core processors, General purpose multi-core processors, speculative multi- threaded architecture. Introduction GPU-GPU Computing.

Textbooks/References:

1. Hennessy and Patterson, "Computer Architecture: A Quantitative Approach," Second Edition, Morgan Kaufmann Publishers, 1996
2. Patterson and Hennessy, "Computer Organization and Design: The Hardware/Software Interface," Morgan Kaufmann Publishers, 1994
3. Multi-core Processors and Systems (Google eBook), Stephen W. Keckler, Kunle Olukotun, H. Peter Hofstee, Springer Science & Business Media.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in Computer Networks	CSEN19902/03

Unit-wise Content distribution

Unit	Contents
Unit-I	**Foundation of Networking Protocols:** 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing, Equal-Sized Packets Model: ATM - Networking Devices: Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure. **The Link Layer and Local Area Networks:** Link Layer: Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization.
Unit-II	**Routing and Internetworking:** Network–Layer Routing, Least-Cost-Path algorithms, Non- Least-Cost-Path algorithms, Intra-domain Routing Protocols, Inter-domain Routing Protocols, Congestion Control at Network Layer **Logical Addressing:** IPv4 Addresses, IPv6 Addresses - **Internet Protocol:** Internetworking,IPv4, IPv6, Transition from IPv4 to IPv6 – **Multicasting Techniques and Protocols:** Basic Definitions and Techniques, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, Node-Level Multicast algorithms.
Unit-III	**Transport and End-to-End Protocols:** Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control – **Application Layer:** Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System(DNS), P2P File Sharing, Socket Programming with TCP and UDP. **Congestion Control and Resource Allocation:** Congestion- Avoidance Mechanisms, DEC bit, Random Early Detection (RED), Source-Based Congestion Avoidance.
Unit-IV	**Wireless Networks and Mobile IP**: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standards, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs) - **Optical Networks and WDM Systems:** Overview of Optical Networks, Basic Optical Networking Devices, Large-Scale Optical Switches, Optical Routers, Wavelength Allocation in Networks, Case Study: An All-Optical Switch.
Unit-V	**Mobile Ad-Hoc Networks:** Overview of Wireless Ad-Hoc Networks, Routing in Ad-Hoc Networks, Routing Protocols for Ad-Hoc Networks – **Wireless Sensor Networks:** Sensor Networks and Protocol Structures, Communication Energy Model, Clustering Protocols, Routing Protocols – **Wireless Mesh Networks:** Introduction- Network Architecture, Characteristics, Application Scenarios, Critical Design Factors.

Textbooks/References:

Text books:

1. Computer Networking: A Top-Down Approach Featuring the Internet, *James F. Kurose, Keith W.Ross*, Third Edition, Pearson Education, 2007.
2. Computer Networks :A System Approach , Larry Peterson and Bruce S Davis 5th Edition,Elsevier -2014
3. Ad hoc Wireless Networks, 2nd Edition, C. Siva Ram Murthy & B. S. Manoj, Pearson Education, 2011
4. Wireless Mesh Networks, first edition, Ian F Akyildiz and Xudong Wang, WILEY Publications, 2009.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in Knowledge Data Discovery	CSEN19902/04

Unit-wise Content distribution

Unit	Contents
Unit-I	An introduction to the Data Mining and Knowledge Discovery Technologies covering all stages of a data mining process: domain understanding, data collection and selection.
Unit-II	Data pre-processing: data cleaning and transformation, dimensionality reduction, pattern discovery, evaluation, and knowledge extraction, Multi-dimensional data modeling.
Unit-III	Classification and prediction, Clustering, Frequent item-set mining.
Unit-IV	Concept Learning, Decision Tree Learning including CART and C4.5, Rule induction and inductive learning, Reinforcement learning, Analytical learning.
Unit-V	Bayesian networks and causality, Artificial Neural networks, Genetic algorithms, Mining special kinds of data including text and graph, Knowledge mining from databases.

Textbooks/References:

1. Discovering Knowledge in Data: An introduction to Data Mining, Daniel T. Larose, John Wiley, 2nd Edition, 2014
2. Data Mining: Concepts and Techniques, By Jiawei Han, Micheline Kamber, 3rd Edition, Morgan Kaufmann Series, 2011

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in Web Intelligence Techniques	CSEN19902/05

Unit-wise Content distribution

Unit	Contents
Unit-I	**Innovations in Web Intelligence:** Introduction, Overview of the Advanced Techniques Used in Web Intelligence, Chapters Included in the Book, Summary. **Advanced Techniques in Web Data Pre-processing and Cleaning :**Introduction, The Nature of the Web Data: General Characteristics and Quality Issues: Web Content, Web Site Structure, Web User Session, Privacy Issues, Quality Measures, Transforming Hyperlinks to a Graph Representation: Hyperlink Retrieval Issues, Crawler Processing, Large Sparse Distributed Storage, Transforming Web Content into a Feature Vector: Cleaning Web Content, Vector Representation of Content, Web Object, Web Session Reconstruction: Representation of the Trails, Proactive Sessionization, Reactive Sessionization, Sessions in Dynamic Environments, Identifying Session Outliers, Summary. **Web Pattern Extraction and Storage:** Introduction: From Data to Knowledge, About Knowledge Representation, General Terms and Definition of Terms, Feature Selection for Web Data: Feature Selection Techniques, Feature Extraction Techniques, Pattern Extraction from Web Data: Supervised Learning Techniques, Unsupervised Techniques, Ensemble Meta-algorithms . Web Mining Model Assessment: Evaluation of Classifiers, Evaluation of Regression Models, MDL Principle, Evaluation of Clustering Models, Evaluating Association Rules, Other Evaluation Criteria, Pattern Webhouse Application: Data Web house Overview, About PMML, Application, Summary.
Unit-II	**Web Content Mining Using Micro Genres:** Introduction, Web Content Mining Summary, Web Usability Basics: Web Design Pattern Basics, Recent Methods, MicroGenre: Pattrio Method, Analysis, Experiments: Accuracy of Pattrio Method, Analysis by Nonnegative Matrix Factorization, Summary. **Web Structure Mining :**Introduction, The Web as a Graph: Facts, Myths, and Traps: The Web Graph, Some Structural Properties of the Web, Web Graph Models, Link Analysis: PageRank, HITS , Spam-Related LAR Algorithms, Structural Clustering and Communities, Algorithmic Issues: Streaming and Semi-streaming Computation Models, Web Graph Compression, Summery.
Unit-III	**Web Usage Mining:** Introduction, Characterizing the Web User Browsing Behaviour: Representative Variables, Empirical Statistics Studies about Web Usage, Amateur and Expert Users, Representing the Web User Browsing Behavior and Preferences : Vector Representations, Incorporating Content Valuations, Web Object Valuation, Graph Representation, The High Dimensionality of Representation, Extracting Patterns from Web User Browsing Behavior: Clustering Analysis, Decision Rules, Integer Programming, Markov Chain Models, Mixture of Markov Models, Hidden Markov Models, Conditional Random Fields, Variable Length Markov Chain (VLMC), Biology Inspired Web User Model, Ant Colony Models, Matrix Factorization Methods, Application of Web Usage Mining, Adaptive Web Sites, Web Personalization, Recommendation, Summary. **User-Centric Web Services for Ubiquitous Computing:** Introduction, Essential Requirements for Providing Web Services in Ubicomp: User Centricity, Context Awareness, Compensability and Reusability, Dynamicity, Current Research in Ubicomp Web Services: Gaia, Aura , ABC Framework, IST Amigo, Task-Oriented Service Framework for Ubiquitous Computing : Task and Action Definition, Overall Architecture of the Framework, Task and Action Semantic Representation Model, Processes for Web Service Composition and Execution in Ubicomp, Implementation and Evaluation, Summary.
Unit-IV	**Ontological Engineering and the Semantic Web:** Introduction to Knowledge Representation and

	Ontology Engineering, A Methodological Approach to Ontology Engineering: The Ontology Development Process according to METHONTOLOGY, The Ontology Lifecycle Model according to METHONTOLOGY, Ongoing Work: Methodologies for Developing Networked Ontologies, Reasoning, Modularization and Customization: State of the Art, Networked Ontologies: Ontology Mapping, Collaboration, Ontology Development Frameworks: Comparison among the Ontology Development Tools, Applications: Natural Interaction: Focus on the User, Semantic Web Services, Collaborative Scenarios for Semantic Applications, Semantic Applications in Public Administrations, Semantic Applications in eBusiness , New Challenges: From Semantic Islands to the Semantic Cloud.
Unit-V	**Web Intelligence on the Social Web:** Introduction , Social Aspects on Communities and Social Networks: Online Social Networks, Virtual Communities ,Virtual Communities of Practice , Social Networks and Virtual Communities Analysis Techniques : Social Network Analysis, Virtual Communities Analysis, Analysis Techniques Drawbacks, Web Mining on Social Web Sites: Basic Web Mining Applications to Study Social Web Sites, Advanced Web Mining Applications to Study Social Web Sites, Summary . **Intelligent Ubiquitous Services Based on Social Networks:** Introduction, Interactive Discovery of Social Networks, Ontology-Based Context Fusion, and Mobile Services by Social Contexts: A Case Study, Experimentation, Discussion, and Summary.

Textbooks/References:

1. Juan D.Vel´asquez and Lakhmi C. Jain (Eds.): Advanced Techniques in Web Intelligence – 1, Springer, Sep-2010.
2. RichiNayak, NikhiIchalkaranje, LakhmiC.Jain: Evolution of the Web in Artificial Intelligence Environments,Springer,2008.
3. Ning Zhong: Web Intelligence Research and Development, Springer,2001.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Advances in System Software and Compiler Design	CSEN19902/06

Unit-wise Content distribution

Unit	Contents
Unit-I	**Introduction to compilers:** Introduction, Theory of computer Languages, Design of a Language, Evolution of Compilers, stages of Compilation. **Lexical analysis:** Introduction, Alphabets and Tokens in Computer Languages, Representation of Tokens and Regular Expression, Token Recognition and Finite State Automata, Implementation, Error Recovery.
Unit-II	**Syntax Analysis & semantic analysis:** Introduction, Context-free Grammar and Structure of Language, Parser and its Types, Top-down Parsers, Bottom up-Parsers, Implementation, Parser Generator Tool(Yacc), Error Handling.
Unit-III	**Intermediate Code generation:** Introduction, Need for Intermediate Code, Types of Intermediate Code, Representations of All Language Constructs by Three-address code, Grammar Symbols and Attributes, Semantic Analysis, Semantic Routines for Intermediate Code Generation. **Optimization:** Introduction, Hints on Writing optimized Code at User Level, Construction of Basic Blocks and Processing, Data-flow Equations for Blocks with Backward Flow Control, Principal Sources of Optimization and Transformations, Alias, Procedural Optimization, Loops in Flow Graphs, Loop Optimization.
Unit-IV	**Code generation:** Introduction, Issues in Code Generation, Target Machine Architecture, Subsequent Use Information, Simple Code Generator, Register Allocation, Directed Acyclic Graph Representation, Code Generation from Intermediate Code, Peephole Optimization. **Compiler Writing tools:** Introduction, Lexical Tools, Syntactic Tools.
Unit-V	**Assemblers:** Basic Assembler Functions, Machine-dependent Assembler Features, Machine-Independent Assembler Features, Assembler Design Options, Implementation Examples. **Loaders and Linkers:** Basic Loader Functions, Machine-Dependent Loader Features, Machine-Independent Loader Features, Loader-Design Options, Implementation Examples.

Textbooks/References:

1. Compilers principles, Techniques and Tools: Alfred V. Aho, Ravi Sethi and Jeffrey D. Ullman, Pearson Education. 2013
2. Compiler Design: Muneeswaran, Oxford University Press, 2013
3. System Software, An Introduction to System Programming: Leland L. Beck and D. Manjula, Pearson Education, 3rd Edition, 2011

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Internet of Things (IoTs)	CSEN19902/07

Unit-wise Content distribution

Unit	Contents
Unit-I	Introduction: Definition, Characteristics of IOT, IOT Conceptual framework, IOT Architectural view, Physical design of IOT, Logical design of IOT, Application of IOT.
Unit-II	Machine -to - machine (M2M), SDN (software defined networking) and NFV(network function virtualization) for IOT, data storage in IOT, IOT Cloud Based Services.
Unit-III	Design Principles for Web Connectivity: Web Communication Protocols for connected devices, Message Communication Protocols for connected devices, SOAP, REST, HTTP Restful and Web Sockets. Internet Connectivity Principles: Internet Connectivity, Internet based communication, IP addressing in IOT, Media Access control.
Unit-IV	Sensor Technology , Participatory Sensing, Industrial IOT and Automotive IOT , Actuator, Sensor data Communication Protocols ,Radio Frequency Identification Technology, Wireless Sensor Network Technology.
Unit-V	IOT Design methodology: Specification -Requirement, process, model, service, functional & operational view.IOT Privacy and security solutions, Raspberry Pi &arduino devices. IOT Case studies: smart city streetlights control & monitoring.

Textbooks/References:

1. Rajkamal,"Internet of Things", Tata McGraw Hill publication

2 Vijay Madisetti and ArshdeepBahga, "Internet of things(A – Hand Approach)" 1st Edition ,Universal Press

3 HakimaChaouchi "The Internet of Things: Connecting Objects",
Wiley publication.

4 Charless Bell "MySQL for the Internet of things", Apress ublications.

5 Francis dacosta "Rethinking the Internet of things:A scalable Approach to connecting everything", 1st edition, Apress publications 2013.

6 Donald Norris"The Internet of Things: Do It Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", McGraw Hill publication.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Machine learning (ML)	CSEN19902/08

Unit-wise Content distribution

Unit	Contents
Unit-I	**INTRODUCTION** Machine learning basics: What is Machine Learning, Types and Applications of ML, Tools used, AI vs ML .Introduction to Neural Networks.Introduction to linear regression: SSE; gradient descent; closed form; normal equations; features, Introduction to classification:Classification problems; decision boundaries; nearest neighbor methods. Linear regression; SSE; gradient descent; closed form;normal equations; features Overfitting and complexity; training,validation, test data, and introduction to Matlab (II).
Unit-II	**SUPERVISED LEARNING:** Introduction to Supervised Learning, Supervised learning setup, LMS, Linear Methods for Classification, Linear Methods for Regression, Support Vector Machines. Basis Expansions, Model Selection Procedures Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naive Bayes, Support vector machines, Model selection and feature selection, Decision Tree, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms. Classification problems; decision boundaries; nearest neighbor methods, Probability and classification, Bayes optimal decisions Naive Bayes and Gaussian class-conditional distribution, Linear classifiers Bayes' Rule and Naive Bayes Model, Logistic regression, online gradient descent, Neural Networks Decision tree and Review for Mid-term, Ensemble methods: Bagging, random forests, boosting A more detailed discussion on Decision Tree and Boosting.
Unit-III	**REINFORCEMENT LEARNING**: Markov decision process (MDP), HMM, Bellman equations, Value iteration and policy iteration, Linear quadratic regulation, Linear Quadratic Gaussian, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.
Unit-IV	**UNSUPERVISED LEARNING:** Introduction to Unsupervised Learning: Association Rules, Cluster Analysis, Reinforcement Learning,Clustering K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis); hierarchical agglomeration Advanced discussion on clustering and EM, Latent space methods; PCA, Text representations; naive Bayes and multinomial models;clustering and latent space models, VC-dimension, structural risk minimization; margin methods and support vector machines (SVM), Support vector machines and large-margin classifiers Time series; Markov models; autoregressive models.
Unit-V	**DIMENSIONALITY REDUCTION**: Feature Extraction, Singular value decomposition. Feature selection –feature ranking and subset selection, filter, wrapper and embedded methods. Machine Learning for Big data: Big Data and MapReduce, Introduction to Real World ML, Choosing an Algorithm, Design and Analysis of ML Experiments, Common Software for ML.

Textbooks/References:

1.Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2.Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC PresS 2009.

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Cloud and Bigdata	CSEN19902/09

Unit-wise Content distribution

Unit	Contents
Unit-I	Historical development ,Vision of Cloud Computing, Characteristics of cloud computing as per NIST , Cloud computing reference model ,Cloud computing environments, Cloud services requirements, Cloud and dynamic infrastructure, Cloud Adoption and rudiments .Overview of cloud applications: ECG Analysis in the cloud, Protein structure prediction, Gene Expression Data Analysis ,Satellite Image Processing ,CRM and ERP ,Social networking .
Unit-II	**Cloud Computing Architecture:** Cloud Reference Model, Types of Clouds, Cloud Interoperability & Standards, Scalability and Fault Tolerance, Cloud Solutions: Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management. Cloud Offerings: Cloud Analytics, Testing Under Control, Virtual Desktop Infrastructure.
Unit-III	**Cloud Management & Virtualization Technology:** Resiliency, Provisioning, Asset management, Concepts of Map reduce , Cloud Governance, High Availability and Disaster Recovery. Virtualization: Fundamental concepts of computer ,storage, networking, desktop and application virtualization .Virtualization benefits, server virtualization, Block and file levelstorage virtualization Hypervisor management software, Infrastructure Requirements , Virtual LAN(VLAN) and Virtual SAN(VSAN) and their benefits .
Unit-IV	**Cloud Security:** Cloud Information security fundamentals, Cloud security services, Design principles, Secure Cloud Software Requirements, Policy Implementation, Cloud Computing Security Challenges, Virtualization security Management, Cloud Computing Secutity Architecture.
Unit-V	Market Based Management of Clouds , Federated Clouds/Inter Cloud: Characterization &Definition ,Cloud Federation Stack , Third Party Cloud Services . Case study: Google App Engine, Microsoft Azure , Hadoop , Amazon , Aneka

Textbooks/References:

1. Buyya, Selvi ," Mastering Cloud Computing ",TMH Pub
2. Kumar Saurabh, "Cloud Computing" , Wiley Pub
3. Krutz , Vines, "Cloud Security " , Wiley Pub
4. Velte, "Cloud Computing-A Practical Approach" ,TMH Pub
5. Sosinsky, " Cloud Computing" , Wiley Pub

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Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Computer Science and Engineering	Data Science	CSEN19902/10

Unit-wise Content distribution

Unit	Contents
Unit-I	**Understanding Data**: Data Wrangling and Exploratory Analysis, Data Transformation & Cleaning, Feature Extraction, Data Visualization. Introduction to contemporary tools and programming languages for data analysis like R and Python.
Unit-II	**Statistical & Probabilistic analysis of Data**: Multiple hypothesis testing, Parameter Estimation methods, Confidence intervals, Bayesian statistics and Data Distributions.
Unit-III	**Introduction to machine learning**: Supervised & unsupervised learning, classification & clustering Algorithms, Dimensionality reduction: PCA & SVD, Correlation & Regression analysis, Training & testing data: Overfitting & Under fitting.
Unit-IV	**Introduction to Information Retrieval:**Boolean Model, Vector model, Probabilistic Model, Text based search: Tokenization,TF-IDF, stop words and n-grams, synonyms and parts of speech tagging.
Unit-V	**Introduction to Web Search& Big data:** Crawling and Indexes, Search Engine architectures, Link Analysis and ranking algorithms such as HITS and PageRank, Hadoop File system & MapReduce Paradigm.

Textbooks/References:

1. Peter Bruce, “Practical Statistics for Data Scientists: 50 Essential Concepts”,Shroff/O'Reilly; First edition, 2017
2.Pang-Ning Tan, “Introduction to Data Mining”, Pearson Edu.
3.Ricardo Baeza-Yates and Berthier Ribeiro-Neto, “Modern Information Retrieval”, Pearson Education
4.Field Cady, “The Data Science Handbook”, 1/e ,2018,Publisher: Wiley
5.Sinan Ozdemir, “Principles of Data Science“, 1/e, 2016Packt Publishing Limited