



**FACULTY OF SCIENCE**

**DEPARTMENT OF COMPUTER AND INFORMATION  
SCIENCE**

**Ph.D.**  
**in**  
**COMPUTER SCIENCE/COMPUTER APPLICATIONS**

**2015 – 2016 ONWARDS**

**ANNAMALAI UNIVERSITY**  
**FACULTY OF SCIENCE**  
**DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE**  
**Ph.D. DEGREE PROGRAMME**  
**SYLLABUS AND ELIGIBILITY**

**Resolution:**

**Resolved to introduce Ph.D. programme in Computer Science/Computer Applications from even semester of the Academic year 2015- 2016 onwards with the following eligibility conditions.**

A pass in M. Sc. or M.S. degree in (Computer Science/Information Technology/Information Science/Software Engineering/Computer Technology/Multimedia) or MCA, and its related disciplines with a minimum of 55% or a First Class in M.Phil. degree in the concerned subject or its equivalent grade point average in the relevant discipline of this university or any other university accepted by the Syndicate as equivalent thereto.

<b>Semester</b>	<b>Course</b>
<b>First</b>	PAPER – I: RESEARCH METHODOLOGY
	PAPER – II: ADVANCED COMPUTING TECHNIQUES (Core Paper)
<b>Second</b>	PAPER – III: Background Paper
	PAPER – IV: Area of Specialization

**Note:**

1. Paper – III (Background Paper) can be selected from the topics listed under-here by the scholar with the consultation of the research supervisor.
2. Paper – IV (Area of Specialization) has to be decided by the research supervisor and the syllabi has to be framed by him or it can be opted from the topics listed below with the consent of the Head of the Department.
  1. Digital Image Processing
  2. Data Mining
  3. Neural Networks and Fuzzy Systems
  4. Software Testing and Quality Assurance
  5. Information Coding Techniques
  6. Advanced Computer Networks
  7. Image Retrieval and Repository

## PAPER – I: RESEARCH METHODOLOGY

### Objectives:

To improve the attitude of higher learning and enhance their aptitude to find new ideas from the existing once, in their academic research activities and its developments. To understand that how to write Technical reports/Scholarly articles.

### UNIT I

**Research Methodology:** Meaning of Research, Objectives of Research, Motivation of Research; Advisor and advisee relationships; Approaches of Research: Analytical, Empirical, Applied research; Fundamental research; Qualitative, Quantitative; Method versus Methodology, Research and Scientific methods. Research Process: Criteria for Good Research, Problem Encountered in Common Research; Funding Agencies.

### UNIT II

**Research Problems and Designing:** Research Problem: Extensive Literature Survey and methods, Problem identification, Problem selection, Problem definition; Techniques Involved in Defining the Problem. Research Design: Needs and Features of Good Design, Different Research Designs; Basic Principles of Experimental Designs; Implementation of the concept designed. Advisor and advisee relationships.

### UNIT III

**Statistical Tools:** Descriptive Statistics: Mean, Median, Standard deviation, Quartile deviation, coefficient of variation. Random noise; Random Field; Markov Random Field; Gaussian Markov Random Field; Hope Field. Probability distribution: Gaussian distribution, t-distribution, F-distribution, Chi-square distribution, Cauchy distribution. Test of Hypothesis: Null hypothesis, Alternate hypothesis; significance level. Correlation and Regression.

### UNIT IV

**Mathematical Tools:** Set theory, Rough set, Solution of non-linear equations; Method of iteration: Newton-Raphson method. Simultaneous linear equations: Gauss elimination method; iterative methods; Eigen values and Eigen vectors of matrices; Power method; Eigen values of symmetric and non-symmetric matrices; solving system of linear algebraic equation by iteration methods.

### UNIT V

**Scientific Papers and Thesis Writing:** Writing Research Paper: Format for Journals, Format for Conferences; Format for Technical Report; Publishing Research Findings in Journals; Impact Factors; Scopus index. Thesis Writing: Layout of the Thesis; Abstract Writing; Presentation of Literature Review; Characterization of Good Thesis; Intellectual contents of the Thesis; Converting your Research Thesis into a Monograph; Plagiarism.

### References:

1. C. R. Kothari, Research Methodology – Methods and Techniques, Third Ed., New Age International Publishers, New Delhi, 2014.
2. R.A Day and A.L. Underwood, Quantitative Analysis, Sixth Ed., Prentice Hall, 1999.
3. S. C. Gupta and V. K. Kapoor, Fundamentals Applied Statistics, Fourth Ed., Sultan Chand and Sons, New Delhi, 2014.
4. S. S. Sastry, Introductory Methods of Numerical Analysis, Fourth Ed., PHI, New Delhi, 2006.
5. Comor and Peter Wood Ford, Writing Scientific Papers in English, Second Ed., Pitman Medical Publishing Co., London, 1979.
6. R. A. Day, How to Write and Publish a Scientific Paper, Cambridge University Press, Fifth Ed., London, 1994.
7. Paul Oliver, Writing your Thesis, Third Ed., Sage Publication Ltd., New Delhi, 2014.

## **PAPER – II: ADVANCED COMPUTING TECHNIQUES (Core Paper)**

### **Objectives:**

In order to equip students with various topics in core idea of the Computer Science and its Applications, and has to enable him to do research in any topic of his choice.

### **UNIT-I**

**Neural Networks and Fuzzy Systems:** Perceptron, Linear Separability, Learning, Hidden layer; Training algorithms; generalized delta rule. Adaptive Resonance Theory, Self-organization Mapping and data processing. Fuzzy Systems: Classical sets to Fuzzy sets, Fuzzy sets versus Crisp sets, Operations on Fuzzy sets, Fuzzy relations.

### **UNIT-II**

**Digital Image Processing:** Fundamentals: Texture images, Structure images, Pixel relationships, Sampling, Quantization. Image Filtering: Smoothing, Sharpening. Image Compression: Lossy and Lossless Compression; Compression standards. Image Segmentation: Region-based Segmentations, Edge linking and boundary detection; Thresholding.

### **UNIT-III**

**Data Mining and Warehousing:** Data Mining: Feature extraction and description, Clustering, Classification, Indexing, Matching and Information Retrieval. Data Warehousing: Design, Dimensional Modelling, Meta data, Performance issues and indexing, VLDB issues, Development life cycle.

### **UNIT-IV**

**Network and Communication Security:** Data Encryption and Decryption: Symmetric, Asymmetric algorithms, Public and private keys, Data encryption standard. Communication Security and Issues: Access control, User authentication, Loss of integrity, Wiretapping, Electronic mail security: IP security, WEB security, Intruders, Viruses, Worms, and Firewalls.

### **UNIT V**

**Parallel Computing:** Parallel Computing Terminology; MIMD Algorithms, Communication on MIMD models Task Scheduling on MIMD systems. Multiprocessor array algorithms: Terminology, Matrix multiplication, Graph algorithms.

### **References:**

1. James Freeman A. and David Skapura M., "Neural Networks – Algorithms, Applications and Programming Techniques", Addison Wesley, 2007.
2. Yegnarayana B., "Artificial Neural Networks", Prentice Hall of India Private Ltd., New Delhi, 2004.
3. George J. Klir and Bo Yuvan, "Fuzzy sets and Fuzzy Logic – Theory and Applications", PHI, 2011.
4. Usama M. Fayyad, Gregory Piatetsky – Shapiro, Padhraí Smyth and Ramasamy Uthrusamy, "Advances in Knowledge Discovery and Data Mining", The M.I.T. Press, 2006.
5. Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Second Ed., Morgan Kaufmann Publishers, 2006.
6. Ralph Kimball, "The Data Warehouse Life Cycle Toolkit", Second Ed., John Wiley and Sons Inc., 2007.
7. William Stallings and Lawrie Brown, Computer Security: Principles and Practices, Second Ed., Prentice Hall, Third Ed., 2015.
8. William Stallings, "Cryptography and Network Security – Principles and practices", Prentice Hall of India, Seventh Edition, 2016.
9. Derek Atkins, "Internet Security", Second Ed Techmedia, 1998.
10. Kernel Texplan, "Communication Network Management", PHI, 1992.
11. Michael J. Quinn, "Designing Efficient Algorithms for Parallel Computers", University of New Hampshire, McGraw Hill Book Company.

**PAPER – III: DIGITAL IMAGE PROCESSING**  
**(Area of Specialization)**

**Objectives:**

To provide complete knowledge on Digital Image Processing methods, and which enables the students to understand the concepts and implement them empirically.

**UNIT-I**

**Fundamentals:** Image Sensing and Acquisition, Image Sampling and Quantization, relationship between Pixels; Random noise; Gaussian Markov Random Field,  $\sigma$ -field, Linear and Non-linear Operations; Image processing models: Causal, Semi-causal, Non-causal models.

**Color Models:** Color Fundamentals, Color Models, Pseudo-color Image Processing, Full Color Image Processing, Color Transformation, Noise in Color Images.

**UNIT-II**

**Spatial Domain:** Enhancement in spatial domain: Point processing; Mask processing; Smoothing Spatial Filters; Sharpening Spatial Filters; Combining Spatial Enhancement Methods.

**Frequency Domain:** Image transforms: FFT, DCT, Karhunen-Loeve transform, Hotelling's  $T^2$  transform, Wavelet transforms and their properties. Image filtering in frequency domain.

**UNIT-III**

**Edge Detection:** Types of edges; threshold; zero-crossing; Gradient operators: Roberts, Prewitt, and Sobel operators; residual analysis based technique; Canny edge detection. Edge features and their applications.

**UNIT-IV**

**Image Compression:** Fundamentals, Image Compression Models, Elements of Information Theory. Error Free Compression: Huff-man coding; Arithmetic coding; Wavelet transform based coding; Lossy Compression: FFT; DCT; KLT; DPCM; MRFM based compression; Wavelet transform based; Image Compression standards.

**UNIT-V**

**Image Segmentation:** Detection and Discontinuities: Edge Linking and Boundary Deduction; Threshold; Region-Based Segmentation. Segmentation by Morphological watersheds. The use of motion in segmentation, Image Segmentation based on Color.

**Morphological Image Processing:** Erosion and Dilation, Opening and Closing, Hit-Or-Miss Transformation, Basic Morphological Algorithms, Gray-Scale Morphology

**Text Books:**

1. Rafael Gonzalez, Richard E. Woods, "Digital Image Processing", Fourth Edition, PHI/Pearson Education, 2013.
2. A. K. Jain, Fundamentals of Image Processing, Second Ed., PHI, New Delhi, 2015.

**References:**

1. B. Chan la, D. Dutta Majumder, "Digital Image Processing and Analysis", PHI, 2003.
2. Nick Elford, "Digital Image Processing a practical introducing using Java", Pearson Education, 2004.

## **PAPER – III: DATA MINING (Area of Specialization)**

### **Objectives:**

To provide complete knowledge on Data Mining methods such as Text Mining, Image Mining, and Managerial Data Mining, and which enables the students to understand the concepts and implement them in practical.

### **UNIT-I**

**Text Mining:** Overview, Textual Information to Numerical Vectors, Document Standardization, Tokenization, Lemmatization, Vector Generation for Prediction, Sentence Boundary Determination, Phrase Recognition, Feature Generation. Using Text for Prediction: Document Classification, Learning to Predict from Text, Evaluation of Performance, Applications.

### **UNIT-II**

**Document Retrieval:** Key Word Search, Nearest-Neighbor Method, Measuring Similarity, Document Matching, Clustering Document by Similarity, Similarity in Composite Documents, Cluster's Labels, Finding Patterns and Entities for Text, Coreference and Relationship Extraction, Template Filling and Database Construction, Applications.

### **UNIT-III**

**Image Mining:** Introduction, Image Database, Evolution, Text-based Image retrieval, Forest of Fuzzy Decision Trees (FFDT), Soft annotation using Bayes points machines, Index annotation, Relevance Feedback techniques, Limitations of text-based image retrieval.

**Feature Extraction:** Color features, Color Space; Color Moments; Color Histogram; Color Coherence Vector; Color Correlogram, JPEG Texture feature, Tamura Features, Wold Feature, Simultaneous Auto-Regressive Model, Gabor Filter Features, Wavelet Transform Features, Shape feature, Moment invariants, Turning Angles, Fourier Descriptors, Circularity, Eccentricity and major Axis Orientation, spatial information.

### **UNIT IV**

**Indexing:** Dimensionality reduction using Principal Component Analysis (PCA), Wavelet Transform – Multidimensional Indexing Techniques - R-tree, Linear quad-trees, K-d-B tree.

**Matching:** Euclidean distance, Minkowski-form distance, Mahalanobis distance, Kullback-Leibler(KL) Divergence, Battacharyya Distance.

**Performance Evaluation:** Recall and Precision Methods, Average Normalized Modified Retrieval Rank (ANMR), F-measure.

**Image Mining tools:** QBIC, VisualSeek, FIRE, RetrievalWare, Webseek.

### **UNIT V**

**Managerial Data Mining:**Data mining in Customer Value and Customer Relationship Management, Business, Sales Marketing and Finance, Banking and Commercial Applications, Insurance, Information analysis and Delivery.

### **References:**

1. Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and techniques, Third Ed., Elsevier, 2011.
2. Sholom Weiss, NitinIndurkhya, Tong Zhang, Fred Damerau, "Text Mining: Predictive Methods for Analyzing Unstructured Information", Springer, 2004.
3. Ronen Feldman, James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006.
4. Manu Konchady, "Text Mining Application Programming", Charles River Media, 2006.
5. Sumathi, S, Sivanantham, S.N., "Introduction to Data Mining and Its Applications", Springer-Verlad, Berlin, Heidelberg, 2006.

**PAPER – III: NEURAL NETWORKS AND FUZZY SYSTEMS**  
**(Area of Specialization)**

**Objectives:**

To gain the knowledge on Neural Network and Fuzzy Systems at advanced level, and which enriches the students to understand the concepts and implement them in practical.

**UNIT-I**

**Back Propagation:** Introduction to Artificial Neural Systems, Perceptron, Representation, Linear separability, Learning, McCulloch-pitts Neuron Model, activation functions. Training algorithm: Back-propagation network, Feed Forward and Feed Backward algorithms, Radial basis function; Genetic algorithm; Generalized delta rule; Hebbian Learning rule, Practical considerations; BPN applications.

**UNIT-II**

**Statistical Methods:** Hopfield nets; Cauchy training; Simulated annealing; The Boltzmann machine. Associative memory; Bidirectional associative memory; its applications.

**UNIT-III**

**Counter Propagation Network and Adaptive Resonance Theory:** CPN building blocks; CPN data processing; SOM data processing; and its applications. Adaptive Resonance Theory: ART network description: ART1, ART2, and applications. Formal avalanche: Architecture of spatio temporal networks; sequential competitive avalanche field; and applications of STNs.

**UNIT-IV**

**NeoCognitron:** Structure and training; neocognitron architecture; Data processing; performance; addition of lateral inhibition; feedback to the neocognitron. Optical neural networks, Holographic correlations.

**UNIT-V**

**Fuzzy Sets:** Classical sets to Fuzzy sets; Fuzzy sets versus Crisp sets; Operations on Fuzzy sets; Fuzzy arithmetic; Fuzzy relations; Fuzzy logic applications. Fuzzy systems: Pattern recognition, Fuzzy databases and Information retrieval systems.

**References:**

1. James Freeman A. and David Skapura M., "Neural Networks – Algorithms, Applications and Programming Techniques", Second Ed., Addison Wesley, 2007.
2. Yegnarayana B., "Artificial Neural Networks", Thirteenth Ed., Prentice Hall of India Private Ltd., New Delhi, 2004.
3. George J. Klir and Boyuvan, "Fuzzy sets and Fuzzy Logic – Theory and Applications", First Ed., PHI, 2009.

**PAPER – III: SOFTWARE TESTING AND QUALITY ASSURANCE  
(Area of Specialization)**

**Objectives:**

To gain the knowledge on Software testing and Quality Assurance at advanced level, and which enriches the students to understand the concepts and implement them in practical.

**UNIT – I**

**Testing Objectives and Principles:** Objectives of Software testing, Software Development Life Cycle (SDLC) and testing; Verification and Validation; Weyuker's adequacy axioms; model for testing and consulting oracles; Possibility of complete testing; Consequence of bugs; Taxonomy of Bugs; Test case Design: Black Box Testing, White Box testing; Testing strategies: Unit testing, Integration Testing, Validation testing, System testing, Debugging and Approaches.

**UNIT – II**

**Basis Path testing:** Data flow testing, Control flow and structure testing, Strategies and Applications; Tools and Effectiveness: Condition Testing, Transaction Flow testing, Syntax Testing; Grammar for formats; Implementation. Loop and Logic Based Testing: Decision tables; Path Expressions; KV Charts. Specifications: State transition Testing; Identifying good and bad states; State testing Metrics and Complexity.

**UNIT – III**

**Graph Based Testing Methods:** Orthogonal Array testing, Performance Testing, Testing Real-time Systems, issues. Testing in Web Applications: Testing object oriented software; Differences from testing Non-OO Software; Testing OOA and OOD models: Class testing strategies, Class Modality, State-based Testing; Message Sequence Specification.

**UNIT – IV**

**Automated Tools for Testing:** Static code analyzers, Test case generators; GUI Testing, Capture/Playback; Stress Testing; Testing Client -server applications; Testing compilers and language processors; Testing web enabled applications. Design for Testability: Observability and Controllability, Built-in Test, Design by Contract, Precondition, Post condition and Invariant, Impact on inheritance, polymorphism.

**UNIT – V**

Regression Testing: Challenges, Test optimization, Mutation testing, Fault based testing, Scenario based testing, Penetration testing. Testing Approaches in Software Industry: testing metrics, functional based metrics; Bang metrics; software quality metrics.

**Reference:**

1. Boris Beizer, "Software Testing Techniques", Second Edition, Dreamtech Press, 2003.
2. Glenford Myers, Corey Sandler, Tom Badgett, "The Art of Software Testing", Second Edition, John-Wiley and Sons, 2004.
3. Roger.S.Pressman, "Software Engineering – A Practitioner's Approach", Eighth Edition, Mc- Graw Hill, 2014.
4. Marnie.L. Hutcheson, "Software Testing Fundamentals", First Ed., Wiley, 2007.
5. William E.Perry, "Effective Methods for Software Testing ", Second Edition, John Wiley and Sons, 2000.
6. Robert V.Binder, "Testing Object-Oriented Systems: Models Patterns and Tools ", First Ed., Addison Wesley, 2000. M. Phil. / Ph .D. Comp. Sci.



## **PAPER-III: INFORMATION CODING TECHNIQUES**

### **(Area of Specialization)**

#### **Objectives:**

To learn about elements of information theory, coding and compression techniques various error control codes and encryption algorithms.

#### **UNIT-I**

Information Entropy Fundamentals: Uncertainty, Information and Entropy – Source coding Theorem – Huffman coding – Shannon Fano coding – Discrete Memory less channels – channel capacity – channel coding theorem–Channel capacity theorem.

#### **UNIT-II**

Data and Voice Coding: Delta Modulation, adaptive Delta Modulation-Coding speech at low bit rates - Adaptive differential Pulse code Modulation - sub-band coding. Audio and Video Coding: Linear predictive coding - code excited LPC – Perceptual coding, MPEG audio coders - Dolby audio coders.

#### **UNIT-III**

Compression Techniques: Principles – Text compression - Static Huffman Coding -Dynamic Huffman coding - Arithmetic coding - Image Compression – Graphics Interchange format - Tagged Image File Format - Digitized documents–Introduction to JPEG standard., – Video compression – Principles - Introduction to H.261and MPEGV standards.

#### **UNIT-IV**

Error Control Coding: Linear Block codes - Syndrome Decoding - Minimum distance consideration – cyclic codes - Generator Polynomial - Parity check polynomial -Encoder for cyclic codes - calculation of syndrome–Convolutional codes.

#### **UNIT-V**

Encryption Coding: Transposition and Substitution coding- Data Encryption Standards (DES)- Key distribution problem- public key encryption- public key decryption and MIT algorithm – Direct sequence CDMA based encryption orthogonal sequences-R-Scodes.

#### **Text Books:**

1. Ranjan Bose, Information Theory, Coding and Cryptography, Second Ed., TMH, New Delhi, 2008.
2. Simon Haykin, "Communication Systems". John Wiley & Sons, 4th edition, 2001.
3. Fred Halsall, "Multimedia Communications, Applications Networks Protocols & Standards", Pearson education, Asia 2002; Chapters:3,4,5.
4. Viterbi,"Information Theorey and Coding", McGraw-Hill, 1982.
5. Proakis,"Digital Communication", McGraw-Hill, 1994.
6. Data Compression Book", BPB publication,1992.

#### **References:**

1. Proakis, "Digital Communication", McGraw-Hill, 1982.
2. Mark Nelson, "Data Compression Book", BPB publication, 1992.
3. Watkinson.J, "Compression in Video and Audio", Focal Press, London, 1995.

**PAPER – III: ADVANCED COMPUTER NETWORKS  
(Area of Specialization)**

**Objectives:**

To understand the concepts of Computer Networks in the following topics at advanced level, and by which the students can be induced to implement the concepts in real-time systems practically.

**UNIT –I**

Topology of Computer Network- Architecture of a Computer Network- Network Architecture Models Partitioning of a system- Layered architecture of a Computer Network – Need for standardization of Network Architecture – Open System interconnection – Layered Architecture of the OSI Reference model – Functionality of the Layered architecture- Hierarchical Communication-Peer to Peer Communication- Service Interface- Data Transfer modes.

**UNIT –II**

LAN Bridge-Transparent Bridges-Spanning Tree Algorithm- Source Routing Bridges-Route Discovery in Source Routing-Network Layer-Wide area Networks-Circuit Switching- Store and Forward Data Networks-Types of Packet switched Data Networks- Purpose of the Network Layer- Network Service.

**UNIT –III**

X.25 Interface-X.25 Services-General Packet Format-Procedures for Switched Virtual Circuits Addressing in X.25-Packet assembler and Disassembler-PAD operation-Frame Relay- Frame Relay Network Topology-Frame Relay Connection-Frame Relay Services- Frame format in Frame Relay-Basic operation of LAP-F-IP Encapsulation-Asynchronous Transfer Mode-UNI and NNI-ATM Virtual Channel connection- Virtual Path Connection-Layered Architecture in ATM-Physical Layer-ATM Layer-ATM Adaption Layer.

**UNIT-IV**

Internet Protocol- Internet Protocol (IP)-Hierarchical Addressing-Subnetting-Address Resolution Protocol-Internet Control Message Protocol (ICMP)-IPV6 Internet Protocol-Point to Point Protocol-Link Control Protocol Quality of Service –Routing-Static Routing-Dynamic Routing-Distance Vector Routing Algorithm- Routing Information Protocol (RIP)-Link state Routing-Open Shortest Path First (OSPF) Routing Protocol.

**UNIT-V**

Transport Layer-Transmission Control Protocol (TCP)-TCP Ports and Connections-Format of TCP segment-TCP operation-Flow Control in TCP-Congestion Avoidance in TCP-Application Layer – TCP/IP Application Protocols-Domain Name System-Bootstrapping Protocol(BOOTP)-Dynamic Host Configuration Protocol (DHCP)-Trivial File Transfer Protocol(TFTP)- File Transfer Protocol(FTP)-Electronic Mail-Simple Network Management Protocol(SNMP).

**Text Book**

1. Data Communications and Computer Networks-Prakash C.Gupta, PHI, Learning Private Limited, 2006.

**Reference:**

1. Computer Network-Tanenbaum-PHI Learning Edition 2012.
2. Data Communication and Networking –Forouzan, Tata McGraw Hill Fourth Edition 2011.

**PAPER III: IMAGE RETRIEVAL AND REPOSITORY**  
**(Area of Specialization)**

**Objective:**

In order to grasp the knowledge on image mining and the image database, and to understand the following techniques involved for image retrieval at implementation level.

**UNIT-I**

**Introduction:** Annotation based image retrieval. Content Based Image Retrieval (CBIR): CBIR architectures; Region-based retrieval, Semantic-based retrieval, Context-based retrieval, Relevance Feedback. Types of image databases; Image Features. Image Clustering; Classification; Matching; Indexing.

**UNIT-II**

**Image database and Features:** Structured image databases, textured image database; image properties; Feature vector database. Image Features: colour based; colour models, texture based, shape based, spatial orientation. Edge and boundary based features.

**UNIT-III**

**Feature Extraction:** Statistical methods: mean, variance, covariance, coefficient of variation, mean vector, covariance matrix, correlation, regression, co-occurrence matrix, Eigen vector. Histogram bins

**UNIT-IV**

**Clustering and Classification:** Clustering: k-means algorithm, c-means algorithm, fuzzy c-means, kNN method, Branch and Bound method, Graph theoretic approach. Classification: Bayes classifier, Quadratic classifier.

**UNIT-V**

**Distance measure:** Point-wise measures: Euclidean distance, Manhattan distance, Canberra distance, Distributional measures: Bhattacharyya distance, Mahalanobis distance, Kullback-Liebler distance, Chi-squared distance, Chebychev. Measure of performance: Precision, recall; F measures.

**References:**

1. Keinosuke Fukunaga, Introduction to Statistical Pattern Recognition, 2<sup>nd</sup> Ed., Academic Press, Inc., New York, 1990.
2. Oge Marques and Borko Furht, Content-Based Image and Video Image Retrieval, Kluwer Academic Publisher, USA, 2002.
3. Sagarmay Deb, Multimedia Systems and Content-Based Image Retrieval, IDEA Group Publishing, USA, 2004.