M.Tech (IT) with Specialization in NETWORK

M.Tech (IT) Course Structure with Different Specializations

M.Tech Creadit Distribution

Semester Number	Mandatory Credit Required	Mandatory Credit Allowed
1	16	16
2	20	20
3	18	18
4	10	10

1. M.Tech (IT) with specialization in Networks

First Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematics for IT	4	2	2	0	HC
2.	Programming Practices	4	2	0	2	HC
3.	Advanced Data Structures	4	2	1	1	HC
4.	Research Methodology	4	2	1	1	HC
	Total	16	24 Hrs.			

Sedond Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Network Programming	4	2	0	2	HC
2.	Advanced Computer Newtorks	4	2	1	1	HC
3.	Network Operating System	4	2	1	1	HC
4.	Elective -1	4	2	1	1	
5.	Project -1	4	0	1	3	
	Total	20	32 Hrs.			

Thrid Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Elective - 2	4	2	1	1	
2.	Elective - 3	4	2	1	1	
3.	Elective - 4	4	2	1	1	
4.	Thesis	6	0	1	5	
	Total	18	30 Hrs.			

Fourth Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Thesis	10	0	1	8	
	Total	10	20 Hrs.			

List of Electives :

1. Mobile and wireless security	2. Cloud Computing	3. Web Engineering	4. Internet & Network Protocols
5. Advanced Digital Communications	6. Wireless Adhoc & Sensor Networks	7. Social Networks and Analytics	8. Image and Video processing
9. Network Simulation	10. Network Management	11. Parallel Computing	12. Cryptography
13. Soft Computing	14. Wireless networks	15. Storage Area Networking	

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Course Syllabus

1. **Name of the Course: Mathematics for IT**
2. **LTP structure of the course: 2-2-0**
3. **Objective of the course:** This course covers Linear algebra; Matrix theory and discrete probability for information technology. Objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving.
4. **Outcome of the course:** Students will learn fundamentals and able to apply these knowledge in practical problems.
5. **Course Plan:**

Component	Unit		Topics for Coverage
Component 1	Unit 1	**Linear Algebra**	Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Subspaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties
	Unit 2		Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition
Component 2	Unit 3	**Discrete Probability**	Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation
	Unit 4		Limit Theorems, Deviations; Markov Chains; Random Walks

6. Text Book:

1. Strang, Gilbert. Introduction to Linear Algebra.
2. Bertsekas, Dimitri, and John Tsitsiklis. *Introduction to Probability.*

Course Syllabus A Template

1. **Name of the Course: Programming Practices**
2. **LTP structure of the course: 2-0-2**
3. **Objective of the course:** To revise basic programming skills and coding data structures for PG (IT) students.
4. **Outcome of the course:** The students will revise their skills in basic programming and data structures. They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Quick overview on C language Pointers and arrays Linked lists Dynamic tables
	Unit 2	Disjoint sets using trees Hashing by chaining Perfect hashing Heaps using trees Search algorithms for graphs (DFS & BFS)
Component 2	Unit 3	Balanced trees B-tree Kruskal's algorithm Eulerian path Hamiltonian cycle
	Unit 4	Shell scripts in Linux environment Programming in bash and whiptail Automatic testing using shell scripts

6. **Text Book:**
7. **References:**
   a. C Programming Language (Ed 2) by *Brian W. Kernighan* and *Dennis M. Ritchie*, Prentice Hall
   b. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   c. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   d. Pro Bash Programming by *Chris F.A. Johnson*, Apress

Course Syllabus A Template

1. **Name of the Course:** Advanced Data Structures and Algorithms
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To covers analysis and design of data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.
4. **Outcome of the course:** Students successfully completing this course will be able to:
   Explain the need for efficiency in data structures and algorithms.
   Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and implementations.
   Understand and apply the concept of abstract data type to represent and implement heterogeneous data structures.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Data Structures Introduction to Computing complexity of operations on data structures Linear Data Structures : Stacks, Queues, Circular Queues Array-Based and Linked List based representation
	Unit 2	Binary Trees and Search Trees Scapegoat Trees Red-Black Trees
Component 2	Unit 3	Sets and Their representations Operations on Sets Strings : Representation and operations Compression and Encoding
	Unit 4	Graphs: Representation and Traversal Graph Algorithms : All source shortest paths, Transitive closure Max-flow - Min-Cut

6. **Text Book:**
7. **References:**
   a. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   b. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   c. Algorithms + Data Structures = Programs by Niklaus Wirth, PHI Learning

Course Syllabus A Template

1. **Name of the Course: Research Methodology**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Core course for Ph.D. students
4. **Outcome of the course:** Learning to conduct research properly
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Research attitude &Choosing research problem	Chapter number from the text book may be given
Component 2	Unit 2	Different types of scientific writing (thesis, paper, review, proposal, popular article)	Chapter number from the text book may be given
	Unit 3	Communicating Science (research journalism, lecture, poster)	Chapter number from the text book may be given
	Unit 4	IPR, Plagiarism, use of computers, search engines, language and grammar	Chapter number from the text book may be given

6. **Text Book:** Mandatory for UG core courses
7. **References:**

1. **Name of the Course: Network Operating System**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course covers the installation, configuration and administration of Network Operating Systems
4. **Outcome of the course:** Students will have both theoretical and practical experience about network operating systems for basic administration of servers. The theoretical part will be oriented to internal structure of network operating systems and the practical part will deal with administration tools designed to manage such operating systems.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction to Network Operating Systems :** System architectures, system calls and IPC mechanisms; active Directory Service; Boot Process and Boot Sequence; Memory management and File System
	Unit 2	**Network Services :**Remote Assistance; Terminal Services; Web, FTP and Print Servers; Internet Applications
Component 2	Unit 3	**Resource Management:** Physical and Logical Drives; Disk Quotas; Share and Map Resources Users and Groups Accounts; Network Access to File Resources; NTFS Permissions
	Unit 4	**Performance and Optimization:**System Monitoring; Performance Monitoring; Backup and Disaster Recovery;Operating System for Mobile Computing

6. **Text Book:**
   Network Operating Systems by *Philip Hunter*

7. **References:**
   a. Networking Operating Systems by *W. J. Buchanan,* Springer

1. **Name of the Course: Cloud Computing**
2. **LTP structure of the course: 3-0-1**
3. **Objective of the course:** To introduce concepts of Cloud Computing.
4. **Outcome of the course:** Upon successful completion, the students will be able to approach designing of parallel computation based better. They shall have not only the theoretical concepts but also practical skill to implement the solutions.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Cloud Computing Paradigm,Recent Trends in ComputingCloud Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing Evolution of cloud computing Business driver for adopting cloud computing defining the Cloud Computing, the roots of Cloud Computing.
	Unit 2	Cloud Computing Architecture, Cloud computing stack Comparison with traditional computing architecture (client/server), Services provided at various levels, working Cloud Computing,Role of Networks in Cloud computing, protocols used, Role of Web services Cloud Computing Deployment models, Cloud service models (IaaS, PaaS, SaaS).Implementing clouds, data centers, hypervisor CPU and memory management, cloud hosted applications, and other advanced and research topics in cloud computing. Infrastructure as a Service(IaaS),Platform as a Service (PaaS),Software as a Service(SaaS).
Component 2	Unit 3	Cloud Computing (NIST Model) Cloud service providers Properties, Characteristics Disadvantages Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing Role of Open Standards Deployment Models Public cloud,Private cloud,Hybrid cloud,Community cloud Service Models (XaaS)Cloud Economics (1): Resource Provisioning in Cloud Computing and cost optimization. Cloud Economics (2): Multitenancy in Cloud Computing, Monitoring in Cloud Computing
	Unit 4	Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations,Security in Cloud Computing.Cloud based service selection, SMI (business key attributes). Resource Virtualization. Server,Storage,NetworkVirtual Machine(resource) provisioning and manageability, storage as a service, Data storage in cloud computing(storage as a service). Introduction to openstack, its implementation, Introduction to different applications such as Applications Microsoft Azure, Amazon Web Services, Salesforces.com,Using Google Web Services.Google App Engine.Case study with different cloud services.

6. **Text Book:** Principles and Paradigms
7. **References:** Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010

- Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011
- Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012
- **Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010**

1. **Name of the Course: Wireless Sensor Network**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course: -** Recent advances in electronics and wireless communications have enabled the development of low cost, low power, small scale, and multi-functional sensor nodes (called motes) that can communicate unmetered in short distances. These motes can be connected together to form wireless sensor networks (WSNs). The constraints of motes make the design and operation of WSNs different than traditional wireless networks and require the development of resource-conscious protocols and management. This course aims at discussing the state-of-the-art in WSNs, including the architecture and protocols involving them and their (potential) application scenarios.
4. **Outcome of the course:-** This course considers the challenges of developing operating systems, wireless networking protocols, power-management, and middle-ware to support this new type of systems. As part of this course, students will design and implement a wireless sensor network system using motes (small devices that integrate a microcontroller and an 802.15.4 radio) or mobile phones.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	• Introduction and overview ✓ Overview of the course; overview of sensor network protocols, architecture, and applications; simulation and experimental platforms; main features of WSNs; research issues and trends.
	Unit 2	• Enabling technologies: Fundamentals of 802.15.4, Bluetooth, and UWB; Physical and MAC layers. • Sensor node hardware and software ✓ Hardware: mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT. ✓ Software (OS): tinyOS, MANTIS, Contiki OS, and RIOT OS. ✓ Programming tools: C, nesC, Mate
Component 2	Unit 3	• Localization, connectivity, and topology :Sensor deployment mechanisms; coverage issues; node discovery protocols. • Network layer protocols: Data dissemination and processing; multi-hop and cluster based protocols; routing.
	Unit 4	• Middleware and application layers ✓ Data dissemination; data storage; query processing; sensorWeb; sensor Grid. • Open issues for future research ✓ Energy preservation and efficiency; security challenges; fault-tolerance;

6. **Text Book:**
   - Sensor Networks and Configuration; *Nitaigour P. Mahalik (Ed.)Springer -2007*
7. **References:**
   - Protocols and Architectures for Wireless Sensor Networks. H. Karl and A. Willig. John Wiley & Sons, June 2005.
   - Wireless Sensor Networks: Technology, Protocols, and Applications. K. Sohraby, D. Minoli, and T. Znati. John Wiley & Sons, March 2007.
   - Wireless Sensor Networks. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors.

Springer Verlag, Sep. 2006.

- Wireless Sensor Networks: Architectures and Protocols. E. H. Callaway, Jr. AUERBACH, Aug. 2003.
- Networking Wireless Sensors. B. Krishnamachari. Cambridge University Press, Dec. 2005.
- Wireless Sensor Networks: An Information Processing Approach. F. Zhao and L. Guibas. Morgan Kaufmann, Jul. 2004.
- Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications. N. P. Mahalik. Springer Verlag, Nov. 2006.
- Wireless Sensor Networks: A Systems Perspective, N. Bulusu and S. Jha, Editors, Artech House, August 2005.

1. **Name of the Course: Parallel Computing**
2. **LTP structure of the course: 3-0-1**
3. **Objective of the course:** To introduce concepts of Parallel Computing.
4. **Outcome of the course:** Upon successful completion, the students will be able to approach designing of parallel computation based better. They shall have not only the theoretical concepts but also practical skill to implement the solutions.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction Motivation Scope of parallel computing Basics of Parallelization
	Unit 2	Mutual exclusion Concurrent objects Principles of parallel algorithm design Scheduling and Work Distribution Foundations of Shared Memory Primitive Synchronization Operations
Component 2	Unit 3	Tools and Platforms: C++11 threads Intel Threading Building Blocks OpenCL and CUD AIntroduction to LAM/MIPCH Issues of Multicore Programming Basic Communication Operations Analytical Modelling of Parallel Programs
	Unit 4	Universality of Consensus Spin Locks and Contention Monitors and Blocking Synchronization Parallel Algorithms & Data Structures Decomposition Techniques Characteristics of Tasks and Interactions Mapping Techniques for Load Balancing Methods for Containing Interaction Overheads Parallel Algorithm Models

6. **Text Book:** The Art of Multiprocessor Programming by Maurice Herlihy and Nir Shavit, Morgan Kaufmann Publishers
7. **References:**
   i. The Art of Concurrency by Clay Breshears, O Reilly
   ii. Introduction to Parallel Computing (2 Ed) by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Addison Wesley Professional C++ by M Gregoire, NA Solter, SJ Kleper (2Ed

Course Syllabus

1. **Name of the Course: Soft Computing**
2. **LTP structure of the course: 2-1-1**
3. Objective of the course: To impart skill in the areas of Machine Learning
4. **Outcome of the course:** To enable students to face the challenges in the area of Machine Learning in the industry with sufficient confidence and enable researchers to develop new concepts in this exciting area.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to learning-intelligence vs autonomy; statistical learning theory, regression analysis, Feature scaling and regularization principle, representing large data with PCA & LDA, concept of recognition, distance based classification. (10 Lectures)
	Unit 2	Artificial Neural network-single layer perceptron, multilayer perceptron, Radial-Basis Function network, accelerated learning in multilayer networks, Hopfield network, Bidirectional Associative Memory, Self Organizing Map, Support Vector Machine, Stochastic Machines- Gibbs sampling, Restricted Boltzman Machine and Deep learning. (20 Lectures).
Component 2	Unit 3	Introduction to Fuzzy logic-Fuzzy thinking, Fuzzy sets, Linguistic variables and hedges, Operations of Fuzzy sets, Fuzzy rules, Fuzzy inference, Building a Fuzzy intelligent system, Basics of neuro –fuzzy system. (10 Lectures)
	Unit 4	Evolutionary Computation-simulation of natural evolution, Genetic algorithm, schema theory, hybrid intelligent system. (5 Lectures).

This is an elective course and a number of reference books and research articles will be followed.

Name of some books are given below:

Reference Books:

1. Introduction to Artificial Intelligence (A guide to Intelligent Systems) by Michael Negnevitsky, Addison Wesley publisher.
2. Neural Networks A comprehensive Foudation by Simon Haykin
3. Fuzzy Logic Intelligence, control, and information by John Yen, Reza Langari. Pearson
4. Genetic Algorithm by D E Goldberg

1. **Name of the Course: Cryptography**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** The objective of this course is to impart knowledge of the basic principles and concepts of modern cryptography. The course will focus on cryptographic problems and their cryptographic solutions. It material will comprise of both theory and applications with an exposure to the techniques that are in practice. The definitions of security and certain construction that meet these definitions shall be taught.
4. **Outcome of the course:** A student will have an understanding of modern cryptography which shall be self- sufficient for any second course in the area of security. Moreover, a student will be able to undertake any work in this area in the industry or research without any other course work.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	1. Introduction (a) What is modern cryptography (b) Historical ciphers and their cryptanalysis (c) The heuristic versus the rigorous approach; adversarial models and principles of defining security 2. Perfectly-Secret Encryption (a) Definitions, the one-time pad; proven limitations 3. Private-Key (Symmetric) Encryption (a) Computational security (b) Defining secure encryption (c) Constructing secure encryption; pseudor and omness (d) Stronger security notions (e) Constructing CPA-secure encryption (f) Modes of operation; CBC vs CTR (g) Security of CTR with n " k bit counter for messages to size 2k blocks with proof directly to the LR definition (h) CCA attacks
	Unit 2	4. Message Authentication Codes (a) Message integrity (b) Definition of security (c) Constructions from pseudo random functions (d) CBC-MAC (e) Authenticated encryption 5. Collision-Resistant Hash Functions (a) Definitions (b) The Merkle-Damgard transform (c) HMAC (d) Birthday attacks (e) The Random oracle model (f) Password hashing 6. Constructions of Pseudorandom Permutations (Block Ciphers) in Practice (a) Substitution-permutation and Feistel networks (b) DES and attacks on reduced-round versions, double-DES and triple-DES

Component	Unit	Topics for Coverage
	Unit 3	(c) AES (d) Hash functions from block ciphers
Component 2		7. Number Theory (a) Preliminaries and basic group theory (b) Primes, factoring and RSA (c) Cryptographic assumptions in cyclic groups (d) Collision resistant hash functions from discrete log 8. Public-Key (Asymmetric) Cryptography (a) Introduction and motivation (b) Diffie-Hellman key exchange
	Unit 4	9. Public-Key (Asymmetric) Encryption (a) The model and definitions (b) Hybrid encryption and KEM/DEM (c) El Gamal (d) RSA: textbook encryption, attacks on textbook RSA, padded RSA; CCA-secure RSA KEM 10. Digital Signatures (a) Definition and applications (b) Hash and sign (c) RSA signatures: textbook RSA, hashed RSA, security with ROM (d) Certificates and public-keyinfrastructures

6. **Text Book:** Mandatory for UG core courses
   Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, second edition 2014, CRC Press.
7. **References:**
   Cryptography: Theory and Practice by Douglas Stinson, Third edition, CRC Press.
   Handbook of Applied Cryptography by Alfred Menezes, Paul Oorschot and Scott Vanstone. Available Online .
   Foundations of Cryptography by Oded Goldreich. Available Online .
   Cryptography, An Introduction by Nigel Smart. Available Online

1. **Name of the Course: Image and Video Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   - To provide the basic understanding of the digital image formation and visualization.
   - To provide the visualization of relationships between spatial and frequency.
   - To provide the understanding of mapping the signal processing techniques to the digital image.
   - To provide an idea of multimedia data (image, video).
   - To provide an exposure to various image and video compression standards.
4. **Outcome of the course:**
   1. The students shall be able to apply the knowledge gained during the course to solve various real time problems.
   2. The students shall be able to develop new state of the art image and video processing method.

Component	Unit	Topics for Coverage
Component 1	Unit 1	Digital Image Fundamentals Simple image model, digital image formation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images. Color ImageProcessing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement Point Processing: Contrast Stretching, Power law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching.
	Unit 2	Filtering and Restoration Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and Nonlinear Filters: Mean and Median Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High boost Filtering. Frequency Domain Filtering: Filtering: Low pass (Smoothing) & High Pass (Sharpening) Ideal, Butterworth and Gaussian Filtering, Unsharp Masking and High Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.
Component 2	Unit 3	Edges, Lines and Boundary Detection First and Second Order Edge Operators, Multi scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection, Morphological Operations and Application: Boundary, Skelton, Convex Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model based and probabilistic methods and Image Classification Optimal and Multilevel Thres holding, Gray ImageSegmentation, Watershed Algorithm.
	Unit 4	Compression: Lossy and Lossless compression techniques, JPEG JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video

6. **Text Book:** Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons
7. **Reference:**

M.Tech (IT) with Specializati on in C.L.I.S.

1. M.Tech (IT) with specialization Cyber Law and Information Security

First Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematics for IT	4	2	2	0	HC
2.	Programming Practices	4	2	0	2	HC
3.	Advanced Data Structures and Algorithms	4	2	1	1	HC
4.	Research Methodology	4	2	1	1	HC
	Total	16	24 Hrs.			

Second Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Cryptography	4	2	0	2	HC
2.	Network security	4	2	1	1	HC
3.	Cyber Law and Security Standards	4	2	1	1	HC
4.	Elective-I	4	2	1	1	
5.	Project-I	4	0	1	3	
	Total	20	32 Hrs.			

Thrid Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Elective - 2	4	2	1	1	
2.	Elective -3	4	2	1	1	
3.	Elective - 4	4	2	1	1	
4.	Thesis	6	0	1	5	
	Total	18	30 Hrs.			

Fourth Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Thesis	10	0	1	8	
	Total	10	20 Hrs.			

List of Electives :

1. Mobile Computing	2. Database Security	3. Block chain and Crypto Currency
4. Internet Protocols	5. Advanced Cryptography	6. Social Network Analysis
7. Wireless Networks	8. BCP & DRP	9. Computer Forensics
10. Intrusion detection system	11. Cyber Security and digital forensic	12. Introduction to information security management
13. Soft Computing	14. Image and video processing	15. Mobile and wireless security

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1. **Name of the Course: Mathematics for IT**
2. **LTP structure of the course: 2-2-0**
3. **Objective of the course:** This course covers Linear algebra; Matrix theory and discrete probability for information technology. Objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving.
4. **Outcome of the course:** Students will learn fundamentals and able to apply these knowledge in practical problems.
5. **Course Plan:**

Component	Unit		Topics for Coverage
Component 1	Unit 1	**Linear Algebra**	Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Sub spaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties
	Unit 2		Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition
Component 2	Unit 3	**Discrete Probability**	Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation
	Unit 4		Limit Theorems, Deviations; Markov Chains; Random Walks

6. **Text Book:**
   1. Strang, Gilbert. Introduction to Linear Algebra.
   2. Bertsekas, Dimitri, and John Tsitsiklis. *Introduction to Probability.*

Course Syllabus A Template

1. **Name of the Course: Programming Practices**
2. **LTP structure of the course: 2-0-2**
3. **Objective of the course:** To revise basic programming skills and coding data structures for PG (IT) students.
4. **Outcome of the course:** The students will revise their skills in basic programming and data structures. They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters.
5. **Course Plan: z**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Quick overview on C languagePointers and arraysLinked listsDynamic tables
	Unit 2	Disjoint sets using treesHashing by chainingPerfect hashingHeaps using trees Search algorithms for graphs (DFS & BFS)
Component 2	Unit 3	Balanced treesB-treeKruskal's algorithmEulerian pathHamiltonian cycle
	Unit 4	Shell scripts in Linux environmentProgramming in bash and whiptailAutomatic testing using shell scripts

6. **Text Book:**
7. **References:**
   a. C Programming Language (Ed 2) by *Brian W. Kernighan* and *Dennis M. Ritchie*, Prentice Hall
   b. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   c. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   d. Pro Bash Programming by *Chris F.A. Johnson*, Apress

Course Syllabus A Template

1. **Name of the Course:** Advanced Data Structures and Algorithms
2. **LTP structure of the course:** 2-1-1
3. **Objective of the course:** To covers analysis and design of data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.
4. **Outcome of the course:** Students successfully completing this course will be able to:
   - Explain the need for efficiency in data structures and algorithms.
   - Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and iplementations.
   - Understand and apply the concept of abstract data type to represent and implement heterogeneous data structures.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Data Structures Introduction to Computing complexity of operations on data structures Linear Data Structures : Stacks, Queues, Circular Queues Array-Based and Linked List based representation
	Unit 2	Binary Trees and Search Trees Scapegoat Trees Red-Black Trees
Component 2	Unit 3	Sets and Their representations Operations on Sets Strings : Representation and opertions Compression and Encoding
	Unit 4	Graphs: Representation and Traversal Graph Algorithms : All source shortest paths, Transitive closure Max-flow - Min-Cut

6. **Text Book:**
7. **References:**
   a. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   b. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   c. Algorithms + Data Structures = Programs by Niklaus Wirth, PHI Learning

Course Syllabus A Template

1. **Name of the Course:** Research Methodology
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Core course for Ph.D. students
4. **Outcome of the course:** Learning to conduct research properly
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1 Component 2	Unit 1	Research attitude &Choosing research problem	Chapter number from the text book may be given
	Unit 2	Different types of scientific writing (thesis, paper, review, proposal, popular article)	Chapter number from the text book may be given
	Unit 3	Communicating Science (research journalism, lecture, poster)	Chapter number from the text book may be given
	Unit 4	IPR, Plagiarism, use of computers, search engines, language and grammar	Chapter number from the text book may be given

6. **Text Book:** Mandatory for UG core courses
7. **References:**

Course Syllabus

1. **Name of the Course: Cryptography**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** The objective of this course is to impart knowledge of the basic principles and concepts of modern cryptography. The course will focus on cryptographic problems and their cryptographic solutions. It material will comprise of both theory and applications with an exposure to the techniques that are in practice. The definitions of security and certain construction that meet these definitions shall be taught.
4. **Outcome of the course:** A student will have an understanding of modern cryptography which shall be self-sufficient for any second course in the area of security. Moreover, a student will be able to undertake any work in this area in the industry or research without any other course work.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	1. Introduction (a) What is modern cryptography (b) Historical ciphers and their cryptanalysis (c) The heuristic versus the rigorous approach; adversarial models and principles of defining security 2. Perfectly-Secret Encryption (a) Definitions, the one-time pad; proven limitations 3. Private-Key (Symmetric) Encryption (a) Computational security (b) Defining secure encryption (c) Constructing secure encryption; pseudorandomness (d) Stronger security notions (e) Constructing CPA-secure encryption (f) Modes of operation; CBC vs CTR (g) Security of CTR with n " k bit counter for messages to size 2k blocks with proof directly to the LR definition (h) CCA attacks
	Unit 2	4. Message Authentication Codes (a) Message integrity (b) Definition of security (c) Constructions from pseudorandom functions (d) CBC-MAC (e) Authenticated encryption 5. Collision-Resistant Hash Functions (a) Definitions (b) The Merkle-Damgard transform (c) HMAC (d) Birthday attacks (e) The Random oracle model (f) Password hashing 6. Constructions of Pseudorandom Permutations (Block Ciphers) in Practice (a) Substitution-permutation and Feistel networks

		(b) DES and attacks on reduced-round versions, double-DES and triple-DES (c) AES (d) Hash functions from block ciphers
Component 2	Unit 3	7. Number Theory (a) Preliminaries and basic group theory (b) Primes, factoring and RSA (c) Cryptographic assumptions in cyclic groups(d) Collision resistant hash functions from discrete log 8. Public-Key (Asymmetric) Cryptography (a) Introduction and motivation(b) Diffie-Hellman key exchange
	Unit 4	9. Public-Key (Asymmetric) Encryption (a) The model and definitions (b) Hybrid encryption and KEM/DEM (c) El Gamal(d) RSA: textbook encryption, attacks on textbook RSA, padded RSA; CCA-secure RSA KEM 10. Digital Signatures (a) Definition and applications (b) Hash and sign(c) RSA signatures: textbook RSA, hashed RSA, security with ROM (d) Certificates and public-keyinfrastructures

6. **Text Book:** Mandatory for UG core courses

   Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, second edition 2014, CRC Press.

7. **References:**

Cryptography: Theory and Practice by Douglas Stinson, Third edition, CRC Press.

Handbook of Applied Cryptography by Alfred Menezes, Paul Oorschot and Scott Vanstone. Available Online .

Foundations of Cryptography by Oded Goldreich. Available Online .

Cryptography, An Introduction by Nigel Smart. Available Online

1. **Name of the Course: Network Security**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course provides an essential study of network security issues and methods in networking systems.
4. **Outcome of the course:** Students can get knowledge about the network security, implementation and requirements after the successful completion of the course
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Network security, Model for Network security, Model for Network access security, Real-time Communication Security: Introduction to TCP/IP protocol stack, Implementation layers for security protocols and implications, IPsec: AH and ESP, IPsec: IKE.
	Unit 2	Media- Based-Vulnerabilities, Network Device Vulnerabilities, Back Doors, Denial of Service (DoS), Spoofing, Man-in-the-Middle, and replay, Protocol - Based Attacks, DNS Attack, DNS Spoofing, DNS Poisoning, ARP Poisoning, TCP/IP Hijacking, Virtual LAN (VLAN), Demilitarization Zone (DMZ) , Network Access Control (NAC), Proxy Server , Honey Pot , Network Intrusion Detection Systems (NIDS) and Host Network Intrusion Prevention Systems Protocol Analyzers, Internet Content Filters, Integrated Network Security Hardware .
Component 2	Unit 3	Authentication: Kerberos, X.509 Authentication Service, Scanning: Port Scanning, Port Knocking- Advantages, Disadvantages. Peer to Peer security. Electronic Mail Security: Distribution lists, Establishing keys, Privacy, source authentication, message integrity, non-repudiation, proof of submission, proof of delivery, message flow confidentiality, anonymity, Pretty Good Privacy (PGP)
	Unit 4	Firewalls and Web Security: Packet filters, Application level gateways, Encrypted tunnels, Cookies. Assignments on latest network security techniques, Security applications in wireless sensor network and wireless Communication networks

6. **Text Book:**
   William Stallings, "Cryptography and Network Security – Principles and Practices", Prentice Hall of India, Third Edition, 2003.
7. **References:**
   Cisco: Fundamentals of Network Security Companion Guide (Cisco Networking Academy Program).
   - Saadat Malik, Saadat Malik. "Network Security Principles and Practices (CCIE Professional Development)". Pearson E ducation. 2002. (ISBN: 1587050250) .
   - Mark Ciampa "Security + Guide to Network Security Fundamentals/Edition 3" Cengage Learning publisher, ISBN-10: 1428340661, ISBN-13: 978-1428340664

1. **Name of the Course: Mobile Computing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course: -**The course is an introduction to the fundamentals of mobile computing. The ubiquity of wireless communication technologies and the proliferation of portable computing devices have made possible a mobile computing era in which users, on the move, can seamlessly access network services and resources, from any-where, at any-time.
4. **Outcome of the course:** - To Impart knowledge on various mobile computing concepts, mobile internet and mobile database management.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1 Unit 2	**Introduction** • Introduction to Mobile Computing • Issues in Mobile Computing • Applications, limitations, and architecture • Mobile Computing Models • Data link layer considerations(Wireless)
		Mobile Network Layer • Mobile IP • Mobile IPv4 and Mobile IPv6 ○ Goals, assumptions, entities and terminology, ○ IP packet delivery, ○ agent advertisement and discovery, ○ registration, tunneling and encapsulation, optimizations WAP Architecture
Component 2	Unit 3	**Mobile Transport Layer** TCP in wired/wireless environments ○ Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP.
	Unit 4	**Data Management** • Data management Issues • Adaptive clustering • Caching • Querying Location Data. • Data Dissemination **Mobile Ad-Hoc Networks** • Basic Concepts • Properties of a MANET • Applications • Design Issues • Routing & protocols • Vehicular Ad Hoc networks

6. **Text Book:**
   - Jochen Burkhardt etal,Pervasive Computing; Technology and Architecture of Mobile Internet Applications, *PEARSON(2014)*

7. **References:**
   - Jochen Schiller,"Mobile Communications",Addison-Wesley. Second edition, 2004.
   - Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing", Wiley, 2002,
   - Abdelsalam A. Helal et al, Any Time, Anywhere Computing : Mobile Computing Concepts and Technology, Kluwer International Series in Engineering and Computer Science, 1999.
   - Evaggelia Pitoura and Geaorge Samaras, Data Management for Mobile Computing, Kluwer International Series on Advances in Database Management,October 1997.

1. **Name of the Course: Database Security**
2. **LTP structure of the course: L:2 T:1 P:1**
3. **Objective of the course:** To understand the security issues and solutions for Database, Multilevel Database, Distributed database, Outsourced Database and Data Warehouse.
4. **Outcome of the course:** Students will get clear idea about database security and how to apply it when the data is at various levels (rest, motion and process) and locations (with data owner and third party).
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Database – Relational Database & Management System – ACID Properties, Normalization, RAID, Relational Algebra, Query tree, Data Abstraction (Physical Level, Logical Level & View Level) -Multi-level Database, Distributed Database, Security issues in Database – Polyinstantiation - Integrity Lock - Sensitivity Lock – Security Models – Access Control (Grant & Revoke Privileges) - Statistical Database, Differential Privacy. Distributed Database Security.
	Unit 2	Outsourced Database and security requirements – Query Authentication Dimension – Condensed RSA, Merkle Tree, B+ Tree with Integrity and Embedded Merkle B-Tree – Partitioning & Mapping - Keyword Search on Encrypted Data (Text file), Security in Data Warehouse & OLAP – Introduction, Fact table, Dimensions, Star Schema, Snowflake Schema, Multi-Dimension range query, Data cube - Data leakage in Data Cube, 1-d inference and m-d inference – Inference Control Methods.
Component 2	Unit 3	Geospatial Database Security – Geospatial data models – Geospatial Authorization, Access Control Models: Geo-RBAC, Geo- LBAC. Database Watermarking – Basic Watermarking Process - Discrete Data, Multimedia, and Relational Data – Attacks on Watermarking - Single Bit Watermarking, Multi bit Watermarking.
	Unit 4	Privacy-Preserving Data Mining – Introduction - Randomization method: Privacy Quantification, Attacks on Randomization, Multiplicative Perturbations, Data Swapping - K- Anonymity framework – Distributed Privacy-Preserving Data Mining, XML – Introduction about XML – Access Control Requirements, Access Control Models: Fine Grained XML Access Control System Streaming.

6. **Text Book:**
   - Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends, ISBN-10: 0387485325. Springer, 2007
7. **References:**
   - Osama S. Faragallah, El-Sayed M. El-Rabaie, Fathi E. Abd El-Samie, Ahmed I. Sallam, and Hala S. El-Sayed, Multilevel Security for Relational Databases by; ISBN 978-1-4822-0539-8. CRC Press, 2014.
   - BhavaniThuraisingham, Database and Applications Security: Integrating Information Security and Data Management, CRC Press, Taylor & Francis Group, 2005.

1. **Name of the Course: Blockchain and Cryptocurrency**
2. **LTP structure of the course: L:2 T:1 P:1**
3. **Objective of the course**: Blockchain and Cryptocurrency is vastly discussed now days in all research domains to bring the decentralization. This course is to understand Blockchain and its main application cryptocurrency. Students will learn how this system works and how can they utilize and what application can be build.
4. **Outcome of the course:** After successful completion of this course, students will be familiar with block chain and cryptocurrency concepts. Also they can build their own application using the learned concepts.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.
	Unit 2	Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Diûculty Level, Sybil Attack, Energy utilization and alternate.
Component 2	Unit 3	Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Crytocurrency Exchange, Black Market and Global Economy.
	Unit 4	Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.

6. **Text Book:**
   - Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
7. **References:**
   - Wattenhofer, The Science of the Blockchain,2016
   - Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 1st Edition, 2015
   - Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
   - DR. Gavin Wood, ``ETHEREUM: A Secure Decentralized Transaction Ledger,''Yellow paper.2014.

1. **Name of the Course: Internet Protocol**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course: -**
   - ✓ Fundamental design principles of Internet Protocols, IP addresses, and IP networks, including routing and forwarding.
4. **Outcome of the course:-**
   - ✓ Apply understanding of Internet protocols by analyzing, evaluating, and improving actual network configurations of IP routers and Internet enables hosts.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Networking** • Layered architectures • Open system Interconnection Reference Model (OSI-RM) • Local, Metropolitan and Wide Area Networks • Wired and Programming Practices s • Ad hoc and Infrastructure LANs • The network layer: Packet switched networking. ATM. IP. • The transport layer: TCP, UDP. Real-time and quality of service protocols. • Addressing: IP addresses and domain naming.
Component 2	Unit 2	**Protocols** • Standard protocols. An example: the Simple Message Transport Protocol for email. • Document formats. E.g. the email message format (RFC 822). • Other application protocols: File Transfer Protocol (FTP) and Telnet. • Intra-domain Routing **Inter-domain Routing**
	Unit 3	**Network Programming** • The design of clients and servers. • The BSD socket network programming interface. Implementing a client.
	Unit 4	**IP Next Generation (IPv6)** • Motivation • IPv6 addressing • IPv6 header format • IPv6 features: routing flexibility, multicast support

6. **Text Book:**

   Douglas Comer," Internetworking with TCP/IP Vol. I: Principles, Protocols", and Architecture;(2006))
7. **References:**

- J. Liebeherr, M. El Zarki, “Mastering Computer Networks: An Internet Lab Manual Addison-Wesley, 2003.
- A.Rodriguez, J.Gatrell, J.Karas, R.Peschkem (2006), TCP/IP Tutorial and Technical Overview, IBM Redbook (available over the Net)
- Comer, D.E. and Stevens, D.L. (1996) Internetworking with TCP/IP: Volume III, BSD socket version, chapters 1, 2, 4, 5, 6 and 7.
- Tanenbaum, A.S. (1993) Computer Networks.
- T. Berners-Lee, R. Cailliau (1990), WorldWideWeb: Proposal for a HyperText Project, 12 November 1990.
  Gray, Robert M. (2010). "Linear Predictive Coding and the Internet Protocol: A survey of LPC and a History of of Realtime Digital Speech on Packet Networks."

Course Syllabus

1. **Course Name: Wireless Network**
2. **LTP structure of the course: 2-1-1**

Syllabus

Objective

This course will discuss current research in wireless communication networks. Various aspects of wireless networking will be covered in this course which include fundamentals of cellular communication, mobile radio propagation, multiple access techniques, mobility support, channel allocation, Wireless PAN/LAN/MAN standards, mobile ad-hoc networks and routing in wireless and mobile networks. The goal of this course is to introduce the students to state-of-the-art wireless network protocols and architectures.

Component	Unit	Topics for Coverage
Component 1	Unit 1	Overview, Wireless Fundamentals, Wireless and Mobile Networking: Facts, Statistics, and Trends, Introduction to Wireless Coding and Modulation, Introduction to Wireless Signal Propagation, Wireless Medium, Medium Access Issues, Energy Models.
	Unit 2	IEEE 802.11 Wireless LANs Basics, Wireless LANs Part II: 802.11a/b/g/n/ac, Introduction to 60 GHz Millimeter Wave Gigabit Wireless Networks, Introduction to Vehicular Wireless Networks and protocols.
Component 2	Unit 3	Internet of Things: protocols and applications, Wireless Protocols for IoT Part I: Bluetooth and Bluetooth Smart, Wireless Protocols for IoT Part II: IEEE 802.15.4 WPAN, Wireless Protocols for IoT Part III: ZigBee, Low Power WAN Protocols for IoT.
	Unit 4	Introduction to Cellular Networks: 1G/2G/3G/4G/5G, Introduction to LTE, Introduction to LTE-Advanced.

Books:

1. Mobile Communications; Jochen Schiller
2. Ad Hoc Networking; Charles E. Perkins.
3. Ad Hoc Mobile Wireless Networks: Protocols and Systems; Toh, C.-K.
4. *Introduction to Wireless and Mobile Systems;* Dharma Prakash Agrawal and Qing-An Zeng, 4th edition.

Course Syllabus

1. **Course Code: Computer Forensics**
2. **LTP credit: L:2 T:1 P:0**
3. **Objective of the Course:** The purpose of this course is to provide the student with basic knowl-edge of Computer Forensics and Investigations focusing on the personal computer. This course covers topics related to criminal justice and computer technology, specically how one can obtains evidence from computer, network, messages and logs, preserving the evidentiary chain, legal as-pects of the search and seizure of computer related equipment and information.
4. **Outcome of the Course:** Students will understand how to do the investigation of any irregular activities.
5. **Course Outline:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction
	Unit 2	Investigations
Component 2	Unit 3	Legal Issues
	Unit 4	Forensics

6. **Text Book:**
   Bill Nelson, Amelia Philips, Frank En nger and Christopher Steuart, Computer Forensics and Investigations, First Edition, Thomson Course Technology.
7. **References:**
   Skoudis, E., Perlman, R. Counter Hack, A Step-By-Step Guide To Computer Attacks And E ective Defenses, Prentice Hall Professional Technical Reference. 2001.
   Mandia, K, Prosise, C, Pepe, M Osbourne, Incident Response & Computer Forensics, 2nd Edition, Mcgraw Hill, 2003.

1. **Name of the Course: Intrusion Detection System**
2. **LTP structure of the course: L:2 T:1 P:1**
3. **Objective** of the course: In order to secure a communication network, it is equally important to defend the network from both external and the internal attackers. Cryptographic algorithms and protocols can only provide defense against the external attackers by implementing some key management mechanism & enforcing authentication of legitimate users in a network. However, in order to identify and prevent the attacks launched by the internal attackers, an Intrusion Detection System (IDS) is essential. This course will explore the use of IDS as part of the overall security polity of a network. Different approaches, models, and algorithms for implementing an IDS system will be discussed, keeping in view the practical issues of deploying the system in an organization environment. Topics include the overview of IDS, anomaly based, signature based and misuse detection based IDS for both host and network environments. The course will give special emphasis on the recent advances and also the open research challenges on this topic.
4. **Outcome of the course:** After successful completion of this course, students will be familiar the important of IDS/IPS over Firewall and Anti-Virus. Students will get the implementation exposure of IDS/IPS in the network as well host.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction: IDS, IPS, Types, Architecture, components, capabilities & Limitations; Main Categories: Network based IDS, Host based IDS, Wireless IDPS, Geo location Based IDS, Localization of device; Network Sniffing Packet Capture and analysis; Signature based IDS, Working with SNORT Rules; Anomaly based IDS, working with BRO; Physical Intrusion detection, BYOD; Application Layer Intrusion detection.
	Unit 2	Web application attacks and firewall; Overview of Intrusion Detection datasets: Dataset sources, Dataset preprocessing, dimensionality Reduction;
Component 2	Unit 3	Intrusion detection products and tools: Developing models for Intrusion detection and prevention, Hybrid Intrusion Detection, Designing a HIDS Model; Vulnerability Analysis in the network; Rule generation and developing rule based intrusion detection models;
	Unit 4	Big data Analytics for intrusion detection models; Clustering techniques; Using classifiers on Intrusion detection datasets; Ensemble methods for intrusion detection; Related Research Works and publication in IDS and IPS

6. **Text Book:**
   - Network Intrusion Detection and Prevention: Concepts and Techniques, Ali A. Ghorbani, Wei Lu, Mahbod Tavallaee
   - Practical Intrusion Analysis: Prevention and Detection for the Twenty-First Century, Ryan Trost
   - Practical Packet Analysis, Chris Sanders
   - Network Intrusion Detection: An Analyst's Handbook, Stephen Northcutt, Judy Novak, Donald McLachlan
7. **References:**
   - Guide to Intrusion Detection and Prevention Systems (IDPS) - Recommendations of the National Institute of Standards and Technology by Karen Scarfone and Peter Mell. Link: “https://www.nist.gov/publications/guide-intrusion-detection-and-prevention-systems-idps”

1. **Name of the Course: Soft Computing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To impart skill in the areas of Machine Learning
4. **Outcome of the course:** To enable students to face the challenges in the area of Machine Learning in the industry with sufficient confidence and enable researchers to develop new concepts in this exciting area.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to learning-intelligence vs autonomy; statistical learning theory, regression analysis, Feature scaling and regularization principle, representing large data with PCA & LDA, concept of recognition, distance based classification. (10 Lectures)
	Unit 2	Artificial Neural network-single layer perceptron, multilayer perceptron, Radial-Basis Function network, accelerated learning in multilayer networks, Hopfield network, Bidirectional Associative Memory, Self Organizing Map, Support Vector Machine, Stochastic Machines- Gibbs sampling, Restricted Boltzman Machine and Deep learning. (20 Lectures).
Component 2	Unit 3	Introduction to Fuzzy logic-Fuzzy thinking, Fuzzy sets, Linguistic variables and hedges, Operations of Fuzzy sets, Fuzzy rules, Fuzzy inference, Building a Fuzzy intelligent system, Basics of neuro –fuzzy system. (10 Lectures)
	Unit 4	Evolutionary Computation-simulation of natural evolution, Genetic algorithm, schema theory, hybrid intelligent system. (5 Lectures).

This is an elective course and a number of reference books and research articles will be followed.
Name of some books are given below:

Reference Books:

1. Introduction to Artificial Intelligence (A guide to Intelligent Systems) by Michael Negnevitsky, Addison Wesley publisher.
2. Neural Networks A comprehensive Foundation by Simon Haykin
3. Fuzzy Logic Intelligence, control, and information by John Yen, Reza Langari. Pearson
4. Genetic Algorithm by D E Goldberg

1. **Name of the Course: Image and Video Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   - To provide the basic understanding of the digital image formation and visualization.
   - To provide the visualization of relationships between spatial and frequency.
   - To provide the understanding of mapping the signal processing techniques to the digital image.
   - To provide an idea of multimedia data (image, video).
   - To provide an exposure to various image and video compression standards.
4. **Outcome of the course:**

   1. The students shall be able to apply the knowledge gained during the course to solve various real time problems.
   2. The students shall be able to develop new state of the art image and video processing method.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Digital Image Fundamentals Simple image model, digital image formation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images. Color Image Processing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement Point Processing: Contrast Stretching, Power law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching.
	Unit 2	Filtering and Restoration Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and Nonlinear Filters: Mean and Median Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High boost Filtering. Frequency Domain Filtering: Filtering: Low pass (Smoothing) & High Pass (Sharpening) Ideal, Butterworth and Gaussian Filtering, Unsharp Masking and High Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.
Component 2	Unit 3	Edges, Lines and Boundary Detection First and Second Order Edge Operators, Multi scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection, Morphological Operations and Application: Boundary, Skelton, Convex Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm.
	Unit 4	Compression: Lossy and Lossless compression techniques, JPEG JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

6. **Text Book:** Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons
7. **Reference:**

Course Syllabus

1. **Course Code : Introduction to Information Security Management**
2. **LTP Credit: 2-1-0**
3. **Objective of the Course:** The purpose of this course is to provide the students with the Foundational concepts of cyber and information security and the key practices and processes for managing security effectively. The course will cover topics like various architecture of information security models, types of security controls, risk management, evolution and testing of security framework
4. **Outcome of the course:** After completing this course the student will get knowledge about the key factors of information security management and its deployment.
5. **Course Outline:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	The Security Environment: Threat, Vulnerabilities and Consequences, Parkerian Model, Access control models to secure the system,
	Unit 2	The use of Risk Management to plan, implement and administer security program and processes. The key elements of Incident management Software program deficiencies and the vulnerabilities associated with them
Component 2	Unit 3	Translating security into a business driver that is critical to meeting the organization's mission
	Unit 4	Metrics and Measurement Models..

6. **Text Book:**
   - Managing Information Security by john R. Vacca (Second Edition)
   - Information Security Risk Assessment Tool Kit by Mark Ryan M. Talabis
7. **Reference Book**
   - Building a Practical Information Security Program by Jason Andress and Mark Leary

M.Tech (IT) with Specialization in H.C.I

1. M.Tech (IT) with specialization in Human Computer Interaction

First Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematics for IT	4	2	2	0	HC
2.	Programming Practices	4	2	0	2	HC
3.	Advanced Data Structures and Algorithms	4	2	1	1	HC
4.	Research Methodology	4	2	1	1	HC
	Total	16	24 Hrs.			

Second Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Cognition and Cognitive Process Modeling	4	2	0	2	HC
2.	Advanced Graphics & Animation	4	2	1	1	HC
3.	Image and Video Processing	4	2	1	1	HC
4.	Elective-1	4	2	1	1	
5.	Project -1	4	0	1	3	
	Total	20	32 Hrs.			

Thrid Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Elective - 2	4	2	1	1	
2.	Elective -3	4	2	1	1	
3.	Elective - 4	4	2	1	1	
4.	Thesis	6	0	1	5	
	Total	18	30 Hrs.			

Fourth Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Thesis	10	0	1	8	
	Total	10	20 Hrs.			

List of Electives :

1. Soft computing	2. Computer Vision	3. Introduction to making learning
4. Virtual Reality	5. Visual Recognition	6. Computational Intelligence
7. Deep Learning	8. Usability	9. Principal of Interaction Design
10. Wireless Ad-hoc and Sensor Network		

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Course Syllabus

1. **Name of the Course: Mathematics for IT**
2. **LTP structure of the course: 2-2-0**
3. **Objective of the course:** This course covers Linear algebra; Matrix theory and discrete probability for information technology. Objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving.
4. **Outcome of the course:** Students will learn fundamentals and able to apply these knowledge in practical problems.
5. **Course Plan:**

Component	Unit		Topics for Coverage
Component 1	Unit 1	**Linear Algebra**	Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Subspaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties
	Unit 2		Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition
Component 2	Unit 3	**Discrete Probability**	Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation
	Unit 4		Limit Theorems, Deviations; Markov Chains; Random Walks

6. **Text Book:**
   1. Strang, Gilbert. Introduction to Linear Algebra.
   2. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability.

1. **Name of the Course: Programming Practices**
2. **LTP structure of the course: 2-0-2**
3. **Objective of the course:** To revise basic programming skills and coding data structures for PG (IT) students.
4. **Outcome of the course:** The students will revise their skills in basic programming and data structures. They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Quick overview on C languagePointers and arraysLinked listsDynamic tables
	Unit 2	Disjoint sets using treesHashing by chainingPerfect hashingHeaps using treesSearch algorithms for graphs (DFS & BFS)
Component 2	Unit 3	Balanced treesB-treeKruskal's algorithmEulerian pathHamiltonian cycle
	Unit 4	Shell scripts in Linux environmentProgramming in bash and whiptailAutomatic testing using shell scripts

6. **Text Book:**
7. **References:**
   a. C Programming Language (Ed 2) by *Brian W. Kernighan* and *Dennis M. Ritchie*, Prentice Hall
   b. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   c. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   d. Pro Bash Programming by *Chris F.A. Johnson*, Apress

Course Syllabus A Template

1. **Name of the Course: Advanced Data Structures and Algorithms**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To covers analysis and design of data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.
4. **Outcome of the course:** Students successfully completing this course will be able to:

   Explain the need for efficiency in data structures and algorithms.

   Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and implementations.

   Understand and apply the concet of abstract data type to represent and implement heterogeneous data structures.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Data Structures Introduction to Computing complexity of operations on data structures Linear Data Structures : Stacks, Queues, Circular Queues Array-Based and Linked List based representation
Component 2	Unit 2	Binary Trees and Search Trees Scapegoat Trees Red-Black Trees
	Unit 3	Sets and Their representations Operations on Sets Strings : Representation and operations Compression and Encoding
	Unit 4	Graphs: Representation and Traversal Graph Algorithms : All source shortest paths, Transitive closure Max-flow - Min-Cut

6. **Text Book:**
7. **References:**
   a. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   b. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   c. Algorithms + Data Structures = Programs by Niklaus Wirth, PHI Learning

Course Syllabus A Template

1. **Name of the Course: Research Methodology**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Core course for Ph.D. students
4. **Outcome of the course:** Learning to conduct research properly
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Research attitude &Choosing research problem	Chapter number from the text book may be given
	Unit 2	Different types of scientific writing (thesis, paper, review, proposal, popular article)	Chapter number from the text book may be given
Component 2	Unit 3	Communicating Science (research journalism, lecture, poster)	Chapter number from the text book may be given
	Unit 4	IPR, Plagiarism, use of computers, search engines, language and grammar	Chapter number from the text book may be given

6. **Text Book:** Mandatory for UG core courses
7. **References:**

Syllabus

1. **Name of the Course: Cognition and Cognitive Process Modeling**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   a. To provide an overview of cognition in human brain.
   b. To introduce students about several AI debates and pro and against arguments of realization of true AI.
   c. To provide comprehensive details about the cutting-edge approaches and recent developments of cognitive systems.
   d. Introducing students about several cognitive architectures and hand-on working in these architectures.
2. **Outcome of the course:**
   a. Students will get the understanding of how human cognition works as per the explanations till date.
   b. Students will get new side of AI development(Using cognitive architectures).
   c. Students will get to know the challenges which have been accomplished and which is yet to be addressed to make true AI systems.
3. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction**Human Brain: Introduction, cognitive faculties: memory, attention, vision and language, What is cognition, introduction about approaches to cognition, theories of mind: mind - body dualism, materialist theory of mind, identity theory of mind, computational theory of mind.
	Unit 2	**Consciousness and Free Will**Consciousness: First person approach , third person approach, Chalmers view of consciousness, problem of third person approach, Pattern-Information duality, Free Will: Sloman view, free will as continuous dimension, design distinctions for agent modeling.
Component 2	Unit 3	**AI Debates**First AI Debate: Is AI possible? Pro: Roger Penrose, moravec, Herbert Simon. Artificial mind via symbolic AI, Turing test of AI. Against: Dreyfus five stages of learning, Searle's chinese room thought experiment, Degrees of understanding, godel's incompleteness theoremSecond AI Debate: Connectionist Model, Objectives of Connectionist model, Feldman's hundred step rules, Brain vs computer model of mind, Lloyd's cautions, Fodor's attack, Chamlmers' defense, Rule based AI.
	Unit 4	**Cognitive Architectures** ACT-R, CLARION, SOAR, Reinforcement Learning, Distributed Cognition, Learning and Memory Architectures. **Projects** 1.Hands-on on cognitive architectures. 2. Analysis of cognition of brain using complex networks.

Books:

1. Artificial Mind by Stan Franklin
2. Siegelbaum, Steven A., and A. J. Hudspeth. Principles of neural science. Eds. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Vol. 4. New York: McGraw-hill, 2000.
3. Research papers for brain modeling.

1. **Name of the Course: Advanced Graphics & Animation**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   The course introduces techniques, algorithms and principles of interactive 3D computer graphics and animation. The course will include a significant practical element for skill extension through lab assignments and a programming project.
4. **Outcome of the course:**
   Upon successful completion of this course, a student should be able to:
- identify and describe the fundamentals of 2D and 3D computer graphics,
- apply mathematics and physics in the design and development of graphics applications,
- describe the basic requirements for computer animation,
- analyze requirements and constraints of 3D viewing, the 3D viewing pipeline, shading and illumination, design and develop interactive 3D programs using the OpenGL 3D graphics library (those who are already familiar with Open GL, may use CUDA/ VTK for graphics programming
- use graphics programming skills and knowledge, including visual debugging, to develop medium-sized interactive 3D graphics & animation application (group assignments).

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Overview, 2D and 3D transformations, Matrix representation of transformations, 2D viewing pipeline, 3D viewing pipeline, Introduction to OpenGL graphic programming,
	Unit 2	Object representation methods, Illumination and color models, Shading, Texture mapping, Graphics Acceleration algorithms such as Level-of-detail rendering, Image-based effects,
Component 2	Unit 3	Different generations of GPUs, Fixed & Programmable-function graphics pipeline, Graphics programming using CUDA, Principles of Animation, Traditional animation method, Key-frame animation, Morphing,
	Unit 4	Advanced topics in Animation such as Facial Animation, Modeling & Animating Human Figure, Physically-based Animation; Group assignments on implementation of a Graphics & Animation Application using open-source toolkits/ libraries such as OpenGL, WebGL, CUDA or packages such as Maya etc.

6. **Text/ Reference Books:**
   1. Rick Parent, "Computer Animation: Algorithms & Techniques", Morgan Kaufmann Pub.
   2. Tomas Akenine-Möller and Eric Haines Naty Hoffman, "Real-Time Rendering, 2nd Ed.", A.K. Peters.
   3. D. Hearn & M.P. Baker, "Computer Graphics with OpenGL", 4th Ed., Pearson Education.
   4. Francis S Hill Jr., Stephen M Kelley, "Computer Graphics Using OpenGL", Prentice Hall of India.
   5. NVidia CUDA Repository, URL: http://developer.nvidia.com/category/zone/cuda-zone.
7. **References** (papers from major conferences/journals):
- SIGGRAPH
- Symposium on Computer Animation (SCA)
- Eurographics
- ACM Trans on Graphics

1. **Name of the Course: Image and Video Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   - o To provide the basic understanding of the digital image formation and visualization.
   - o To provide the visualization of relationships between spatial and frequency.
   - o To provide the understanding of mapping the signal processing techniques to the digital image.
   - o To provide an idea of multimedia data (image, video).
   - o To provide an exposure to various image and video compression standards.
4. **Outcome of the course:**
   1. The students shall be able to apply the knowledge gained during the course to solve various real time problems.
   2. The students shall be able to develop new state of the art image and video processing method.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Digital Image Fundamentals Simple image model, digital imageformation, sampling, quantization, resolutions and representation,relationship among pixels, types of digital images. Color Image Processing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement Point Processing: Contrast Stretching, Power law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching. Filtering and Restoration Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and
	Unit 2	Nonlinear Filters: Mean and Median Filters, AdaptiveFiltering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High boost Filtering. Frequency Domain Filtering: Filtering: Low pass (Smoothing) & High Pass (Sharpening) Ideal, Butterworth and Gaussian Filtering, Unsharp Masking and High Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.
Component 2	Unit 3	Edges, Lines and Boundary Detection First and Second Order Edge Operators, Multi scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection, Morphological Operations and Application: Boundary, Skelton, Convex Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm.
	Unit 4	Compression: Lossy and Lossless compression techniques, JPEG JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

6. **Text Book:** Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons
7. **Reference:**

Syllabus

1. **Name of the Course: Computer Vision**
2. **Objective of the course:**
   To provide an overview of how human brain does vision processing.
   To give an introduction about modeling aspect of low-level, intermediate level visual processing: Neuromorphic vision computing To give a perspective of machine vision through single camera and stereo vision technologies.
   To give an intuition about machine modeling of 3D structure, motion, activity and so on.
   Brain inspired modeling of high level vision processing such as object recognition, face recognition, activity analysis and so on.
3. **Outcome of the course:**
   a. Students will learn basics of stereo vision and algorithms.
   b. Students will get glimpse of efficiency of human brain vision.
   c. Students will get new perspective of brain inspired computational vision.
   d. Students will be able to look at the world in the form of matrices and model the activity happening in world
4. **Reference frame**
   a. By doing projects they will be able to apply the grabbed knowledge to real problems.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction**Human Vision and Computer Vision ; Eye and Brain;Low, Intermediate and High level Vision processes;Historical Perspectives, Theoretical approaches toVisual Perception and Processing; Visual Illusions;Structuralism, Gestaltism, Ecological Optics and Constructivism; Marr's 2.5 D Sketch; Color Perceptionand Processing, neuromorphi c computing.
	Unit 2	Viewing through Camera; Multiview Geometry Camera, Image and World Reference Frames; Views and Coordinates Transformations:Orthogonal, Euclidean, Affine, Projective; Camera Calibration. Perspective, and Epipolar Geometry, Binocular Stereopsis, Homography, Rectification, DLT,RANSAC, Depth Map and 3D reconstruction framework, Depth Estimation, stitching. Component High Level one Vision Processing Understanding images and scenes, Four Stages of Visual Perception, Feature level Processing (Edges, Lines, Corners), Surfaces Extraction; Segmentation and Classification; Representations and Organizations of Objects and Scenes; 3D Scene Analysis; Size and Shape Constancy and Illusions; Using knowledge and learning for Object and Scene Recognition, Brain Inspired High level vision computing, Simulation of Visual Attention and Visual Memory Processes.
Component 2	Unit 3	Shape from X and Motion AnalysisLight at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, Shape from Texture, color, motion and edges. Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo, Motion parameter estimation; Motion Models and Analysis; Rigid and Non – Rigid Body Motion; Self Motion, Gesture and activity recognition.
	Unit 4	1. Projects on applying computer vision algorithms to the real world problem 2. Modeling of brain inspired vision solutions and applying these solutions to solve problems.

Books:

Computer Vision: Algorithms and Applications, Richard Szeliski, Springer-Verlag London Limited 2011.

1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

   Vision Science : Photons to Phenomenology, MIT Press, Cambridge, 1999.

4. Handbook of Computer Vision, Vol.1, Vol.2, Vol.3 : Bernd Jahne, Horst

   Haubecker, and Peter Geibler (Eds.), Academic Press, London, 1999.

5. Siegelbaum, Steven A., and A. J. Hudspeth. Principles of neural science. Eds. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Vol. 4. New York: McGraw-hill, 2000.

6. Purves, D. et al (2008) Neuroscience 4th edition. Sinauer Associates, Sunderland, MA

1. **Name of the Course: Virtual Reality**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**

   Virtual Reality (VR) is changing the interface between people and information technology by offering new ways for the communication of information, the visualization of processes, and the creative expression of ideas. The course objective is to promote the understanding of this technology, underlying principles, its potential and limits and to learn about the criteria for defining useful applications. Furthermore, each student will be exposed to the process of creating virtual environments, by developing a complete VR or Augmented Reality (AR) application as members of a small team.

4. **Outcome of the course:**

   The students will learn a ton about Virtual and Augmented Reality, get familiar with the latest technology, techniques and software, and build an application during the course. There will also be seminar presentations on research topics/articles (published in reputed journals/ advanced books) related with VR/AR by the postgraduate students.

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction, Components of a VR system, 3D User Interface Input and Output devices, 3D viewing, Designing & Building VR Systems, Introduction to Augmented Reality (AR),
	Unit 2	VR Modeling: Geometric modeling, Kinematic, Physical and Behavior modeling; Selection and Manipulation during 3D Interaction,
Component 2	Unit 3	Travel and Wayfinding in Virtual Environments, Strategies for Designing and Developing 3D UIs, Evaluation of 3D User Interfaces, Traditional and Emerging VR/AR applications,
	Unit 4	Human Factors in Virtual Reality, Case study on Construction of Geographic Virtual World. Group assignments on implementation of a Virtual/ Augmented Reality Application using open-source toolkits/ libraries such as Open Scene Graph, Vega, VRML etc.

6. **Text/ Reference Books:**
   1. G.C. Burdea & P. Coiffet, “Virtual reality Technology, Second Ed.”, Wiley-India.
   2. GJ Kim, “Designing VR Systems: The Structured Approach”, Springer.
   3. D.A. Bowman et al., “3D User Interfaces: Theory and Practice”, Addison Wesley.
   4. John Vince, “Virtual Reality Systems”, Pearson Ed.
   5. Rick Parent, “Computer Animation: Algorithms & Techniques”, Morgan Kaufmann.
7. **References (papers from major conferences/journals):**
   - SIGGRAPH
   - Symposium on Computer Animation (SCA)
   - Eurographics
   - ACM Trans on Graphics

1. **Name of the Course: Visual Recognition**
2. **LTP structure of the course: 211**
3. **Objective of the course:** The field of visual recognition has become part of our lives with applications in self-driving cars, satellite monitoring, surveillance, video analytics particularly in scene understanding, crowd behaviour analysis, action recognition etc. It has eased human lives by acquiring, processing, analyzing and understanding digital images and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information. The visual recognition encapsulates image classification, localization and detection. The course on visual recognition will help students understand new tools, techniques and methods which are influencing the visual recognition field.
4. **Outcome of the course**: At the end of this course, the students will be able apply the concepts to solve some real problems in recognition. The students will be able to use computational visual recognition for problems ranging from extracting features, classifying images, to detecting and outlining objects and activities in an image or video using machine learning and deep learning concepts. The student will be also being able to invent new methods in visual recognition for various applications.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Course Introduction: Computer vision overview, Historical context, Visual recognition introduction. Image Classification: Localization and Detection, The data-driven approach, K-nearest neighbour, Linear classification, Linear classification – II, Higher-level representations, image features, Properties of features, SIFT, SURF, LBP, HOG and ORB. Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description.
	Unit 2	Introduction to Neural Networks: Backpropagation, Multi-layer Perceptrons, The neural viewpoint, Activation functions, initialization, dropout, batch normalization, Update rules, ensembles, and data. Optimization: Stochastic gradient descent, Mini Batch Gradient Descent, Nesterov accelerated gradient, Adagrad, AdaDelta, Rmsprop augmentation, transfer learning.
Component 2	Unit 3	Visual Recognition Libraries and Tools: Caffe, Torch, Theano, TensorFlow, Keras, PyTorch, etc. Architectures for Visual Recognition: Convolution Neural Network: History ; Convolution and pooling ; ConvNets outside vision, AlexNet, VGG, GoogLeNet, ResNet, etc, ;
	Unit 4	Convolutional Networks with Variable-sized Inputs, Intro to YOLO Single Shot Object Detection; Deep Feature Learning methods, Representation learning, Transfer Learning.Learning based Segmentation: RNN, LSTM, GRU, Language modeling, Image captioning, visual question answering, Soft attention. Generative Models: PixelRNN/CNN, Variational Autoencoders, Generative Adversarial Networks. Recent Research Trends: Biometrics; Video Analytics: Scene Understanding, Action Recognition , Crowd Behavior Analysis, Surveillance Systems; Super resolution, Emotion Recognition & Stress Detection etc.

6. Text Book: No specific Text Book
7. Reference:

Course Syllabus for Deep Learning

1. **Name of the Course: Deep Learning**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To get the students and researchers exposed to the state of the art deep learning techniques, approaches and how to optimize their results to increase its efficiency and get some hands-on on the same to digest the important concepts.
4. **Outcome of the course:** As deep learning has demonstrated its tremendous ability to solve the learning and recognition problems related to the real world problems, the software industries have accepted it as an effective tool. As a result there is a paradigm shift of learning and recognition process. The students and researchers should acquire knowledge about this important area and must learn how to approach to a problem, whether to deal with deep learning solution or not. After undergoing this course they should be able to categorize which algorithm to use for solving which kind of problem. Students will be able to find out the ways to regularize the solution better and optimize it as per the problem requirement. Students will be exposed to the background mathematics involved in deep learning solutions. They will be able to deal with real time problems and problems being worked upon in industries. Taking this course will substantially improve their acceptability to the machine learning community – both as an intelligent software developer as well as a matured researcher.

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basic concepts of perceptron, learning andrecognition- supervise and unsupervised learning. Fundamentals of delta learning rules and back propagation algorithm, SVM, KNN. Machine Learning, machine learning techniques, challenges motivating deep learning. over fitting and under fitting, bias and variance, Gradient based optimization, Maximum LikelihoodEstimation. Deep Feed-forward network, backpropagation. SomeRegularization and Optimization Techniques
	Unit 2	
Component 2	Unit 3	Convolutional Neural Network, RNN, methodology and Applications of deep learning
	Unit 4	Linear Factor Models and Autoencoders Monte Carlo Methods, Stochastic Maximum, Likelihood and Contrastive Divergence
		Deep Generative Models: Boltzmann Machine, RBM, Deep Belief Nets, Deep Boltzmann Machine, Convolutional Boltzmann Machine

6. **Text Book:**
   Deep Learning by- Ian Goodfellow, Yoshua Bengio and Aaron Courville
   In addition other machine learning books , research papers etc. will be used.

Course Syllabus

1. **Name of the Course: Soft Computing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To impart skill in the areas of Machine Learning
4. **Outcome of the course:** To enable students to face the challenges in the area of Machine Learning in the industry with sufficient confidence and enable researchers to develop new concepts in this exciting area.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to learning-intelligence vs autonomy; statistical learning theory, regression analysis, Feature scaling and regularization principle, representing large data with PCA & LDA, concept of recognition, distance based classification. (10 Lectures)
Component 2	Unit 2	Artificial Neural network-single layer perceptron, multilayer perceptron, Radial-Basis Function network, accelerated learning in multilayer networks, Hopfield network, Bidirectional Associative Memory, Self Organizing Map, Support Vector Machine, Stochastic Machines- Gibbs sampling, Restricted Boltzman Machine and Deep learning. (20 Lectures).
	Unit 3	Introduction to Fuzzy logic-Fuzzy thinking, Fuzzy sets, Linguistic variables and hedges, Operations of Fuzzy sets, Fuzzy rules, Fuzzy inference, Building a Fuzzy intelligent system, Basics of neuro –fuzzy system. (10 Lectures)
	Unit 4	Evolutionary Computation-simulation of natural evolution, Genetic algorithm, schema theory, hybrid intelligent system. (5 Lectures).

This is an elective course and a number of reference books and research articles will be followed.
Name of some books are given below:

6. Reference Books:
   1. Introduction to Artificial Intelligence (A guide to Intelligent Systems) by Michael Negnevitsky, Addison Wesley publisher.
   2. Neural Networks A comprehensive Foudation by Simon Haykin
   3. Fuzzy Logic Intelligence, control, and information by John Yen, Reza Langari. Pearson
   4. Genetic Algorithm by D E Goldberg

Course Syllabus

Principles of Interaction Design (PID)

Component	Unit	Topics for Coverage
Component 1	Unit 1 Unit 2	Brief overview of HCI: Origins and definitions of HCI, brief history, Components of HCI, Various disciplines that participate in HCI, Motivations for human factors in design, Need to understand people/ users, computers and methods.Human issues: Cognition, Visual and auditory perception, Memory & learning, Cognitive models & frameworks, Vision, Perception and Interface metaphors.
		Interaction: Interaction devices, Models of interaction, Interaction/dialog styles, menu selection, form filling and dialog boxes, command, speech and natural languages, direct manipulation and virtual environments, Effective information presentation and Common interface paradigms.
Component 2	Unit 3	Interface design methods: User-centered design, LUCID model, User task analysis, Formal methods for user-interface (UI) specifications (including Grammar, Menu Selection Tree, Transition Diagram, Statechart and User action notation) , Prototyping, Storyboards, Design principles and rules, Process of interface design & its elements.
	Unit 4	Interface evaluation: Interface evaluation methodologies, Usability issues, ISO 9241 framework of usability, Usability testing steps, Expert reviews, Heuristic evaluation, Cognitive walkthrough, Benchmarks and experiments, Surveys and Acceptance test.User Experience (UX) Design: Define UX design roles and responsibilities, Adapt UX design and Usability Principles and Guidelines, Realized that UIs are “visualized requirements”, Base the design thinking on business requirements, Adapt a user-centered business analysis and UX design methodology, Apply change management in deployment of the new user-center methodology.

References:

1. David Benyon, “Designing Interactive Systems – 2nd Ed.”, Addison Wesley.
2. Alan Dix et. al., “Human-Computer Interaction”, Pearson Education.
3. Ben Shnerderman, “Designing the user interface: Strategies for Effective Human-Computer Interaction”, Pearson Education.
4. Jenny Preece, “Human-Computer Interaction”, Addison Wesley.
5. Emrah Yayici, "UX Design and Usability Mentor Book: With Best Practice Business Analysis and User Interface Design Tips and Techniques", Paperback, 2014.
6. Christine Faulkner, "The Essence of Human-Computer Interaction", Prentice Hall.
7. Don Norman, “Design of Everyday Things”, Basic Books.

1. **Name of the Course : Computational Intelligence**
2. **LTP Structure: 2-1-1**
3. **Objective of the Course:** The subject aims to introduce students to fundamentals of key intelligent systems technologies including knowledge-based systems, machine learning, fuzzy systems, and evolutionary computation.
4. **Outcome of the Course:** Upon completion of the subject, students shall be able to gain a working knowledge of knowledge-based systems, machine learning, fuzzy systems, and evolutionary computation. Also able to apply intelligent systems technologies in a variety of engineering applications.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction,Bayesian classification* - Review of Bayes Theorem; a priori, class conditional and posterior probabilities; using Bayes theorem as a classifier; Bayesian belief networks. Nearest neighbour classification;
	Unit 2	*Machine learning* - Supervised, unsupervised and semi-supervised learning. Supervised learning* - Discriminant functions; learning linear discriminant functions; Decision boundaries; learning linear decision boundaries; Perceptron learning; Single perceptron;Multi layer perceptrons. Deep Neural Networks, Unsupervised learning.
Component 2	Unit 3	Fuzzy sets* - Introduction to fuzzy sets; mathematical operations on fuzzy sets; fuzzy decision theory; fuzzy K means clustering.
	Unit 4	Evolutionary and hybrid methods

6. **Text Books:**

Kumar Satish, “Neural Networks: A Classroom Approach”, TMG, 2012.

S. Haykin, Neural Networks – A Comprehensive Foundation, Prentice Hall, 1999.A. P. Engelbrecht, Computational Intelligence: An Introduction, John Wiley & Sons, 2007.X. Yu and M. Gen, Introduction to Evolutionary Algorithms, Springer Verlag, 2010.

7. **References:**

TJ Ross, Fuzzy Logic with Engineering Applications, Wiley, 2010.

E. Cox, The Fuzzy Systems Handbook, Boston: AP Professional, 1998.

S. Russell and P. Norvig. Artificial Intelligence – A Modern Approach, Prentice Hall, 2010.

1. **Name of the Course: Wireless Sensor Network**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** - Recent advances in electronics and wireless communications have enabled the development of low cost, low power, small scale, and multi-functional sensor nodes (called motes) that can communicate unmetered in short distances. These motes can be connected together to form wireless sensor networks (WSNs). The constraints of motes make the design and operation of WSNs different than traditional wireless networks and require the development of resource-conscious protocols and management. This course aims at discussing the state-of-the-art in WSNs, including the architecture and protocols involving them and their (potential) application scenarios.
4. **Outcome of the course:**- This course considers the challenges of developing operating systems, wireless networking protocols, power-management, and middle-ware to support this new type of systems. As part of this course, students will design and implement a wireless sensor network system using motes (small devices that integrate a microcontroller and an 802.15.4 radio) or mobile phones.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	• Introduction and overview ✓ Overview of the course; overview of sensor network protocols, architecture, and applications; simulation and experimental platforms; main features of WSNs; research issues and trends.·
	Unit 2	• Enabling technologies: Fundamentals of 802.15.4, Bluetooth, and UWB; Physical and MAC layers. • Sensor node hardware and software ✓ Hardware: mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT.
Component 2	Unit 3	• Software (OS): tinyOS, MANTIS, Contiki OS, and RIOT OS. Programming tools: C, nesC, Mate·
	Unit 4	• Localization, connectivity, and topology :Sensor deployment mechanisms; coverage issues; node discovery protocols. · • Network layer protocols: Data dissemination and processing; multi-hop and cluster based protocols; routing.·
		• Middleware and application layers Data dissemination; data storage; query processing; sensor Web; sensor Grid.· • Open issues for future research Energy preservation and efficiency; security challenges; fault-tolerance; · Middleware and application layers ✓ Data dissemination; data storage; query processing; sensor Web; sensor Grid. • Open issues for future research ✓ Energy preservation and efficiency; security challenges; fault-tolerance;

6. **Text Book:**
   - Sensor Networks and Configuration; Nitaigour P. Mahalik (Ed.)Springer -2007
7. **References:**
   - Protocols and Architectures for Wireless Sensor Networks. H. Karl and A. Willig. John Wiley & Sons, June 2005.
   - Wireless Sensor Networks: Technology, Protocols, and Applications. K. Sohraby, D. Minoli, and T. Znati. John Wiley & Sons, March 2007.
   - Wireless Sensor Networks. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors. Springer Verlag, Sep. 2006.

- Wireless Sensor Networks: Architectures and Protocols. E. H. Callaway, Jr. AUERBACH, Aug. 2003.
- Networking Wireless Sensors. B. Krishnamachari. Cambridge University Press, Dec. 2005.
- Wireless Sensor Networks: An Information Processing Approach. F. Zhao and L. Guibas. Morgan Kaufmann, Jul. 2004.
- Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications. N. P. Mahalik. Springer Verlag, Nov. 2006.
- Wireless Sensor Networks: A Systems Perspective, N. Bulusu and S. Jha, Editors, Artech House, August 2005.

1. **Name of the Course: Introduction to Machine Learning**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course gives an introduction to machine learning. It is about unified understanding of the models and algorithms used in machine learning.
4. **Outcome of the course:** Students will be able to understand basic concept and they will be able to successfully apply it on real data set.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Decision Trees and K-Nearest-Neighbors, Linear and Ridge Regression, Perceptron, Support Vector Machines (SVM), Kernels and nonlinear SVMs,
	Unit 2	Model Selection, Feature Selection. Ensemble Methods. Hierarchical and Flat Clustering, Gaussian Mixture Models, Linear Dimensionality Reduction
Component 2	Unit 3	Matrix Factorization, Nonlinear Dimensionality Reduction and Manifold Learning.
	Unit 4	Artificial Neural Network (Forward/Back propagation); Reinforcement Learning and Hidden Markov Model.

6. **Text Book:** Christopher Bishop, "Pattern recognition and machine learning", Springer, 2007.Richard
7. **References:**

   1. Duda, Peter Hart, David Stork, "Pattern Classification", Wiley; Second edition
   2. Tom Mitchell, "Machine Learning".
   3. Hal Daumé III, A Course in Machine Learning (http://ciml.info), 2015
   4. Kevin Murphy, "Machine learning: a probabilistic perspective", MIT Press, 2012.

M.Tech (IT) with Specialization in M.L.I.S.

6. M.Tech (IT) with specialization in Machine Learning and Intelligent Systems

First Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematics for IT	4	2	2	0	HC
2.	Programming Practices	4	2	0	2	HC
3.	Advanced Data Structures and Algorithms	4	2	1	1	HC
4.	Research Methodology	4	2	1	1	HC
	Total	16	24 Hrs.			

Second Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Introduction to Machine Learning	4	2	0	2	HC
2.	Cognition and Cognitive Process Modeling	4	2	1	1	HC
3.	Convex optimization	4	2	1	1	HC
4.	Elective-1	4	2	1	1	
5.	Project -1	4	0	1	3	
	Total	20	32 Hrs.			

Thrid Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Elective - 2	4	2	1	1	
2.	Elective -3	4	2	1	1	
3.	Elective - 4	4	2	1	1	
4.	Thesis	6	0	1	5	
	Total	18	30 Hrs.			

Fourth Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Thesis	10	0	1	8	
	Total	10	20 Hrs.			

List of Electives :

1. Computer Vision	2. Natural Language Processing	3. Deep Learning
4. Information Retrieval	5. Pattern Recognition	6. Social Network Analysis
7. Biometric	8. Advance Data Analytics	9. Probabilistic Machine Learning and Graphical Model
10. Virtual Reality	11. Soft Computing	11. Image and Video Procesing

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Allahabad

Course Syllabus

1. **Name of the Course: Mathematics for IT**
2. **LTP structure of the course: 2-2-0**
3. **Objective of the course:** This course covers Linear algebra; Matrix theory and discrete probability for information technology. Objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving.
4. **Outcome of the course:** Students will learn fundamentals and able to apply these knowledge in practical problems.
5. **Course Plan:**

Component	Unit		Topics for Coverage
Component 1	Unit 1	**Linear Algebra**	Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Subspaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties
	Unit 2		Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition
Component 2	Unit 3	**Discrete Probability**	Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation
	Unit 4		Limit Theorems, Deviations; Markov Chains; Random Walks

6. **Text Book:**
   1. Strang, Gilbert. Introduction to Linear Algebra.
   2. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability.

Course Syllabus A Template

1. **Name of the Course: Programming Practices**
2. **LTP structure of the course: 2-0-2**
3. **Objective of the course:** To revise basic programming skills and coding data structures for PG (IT) students.
4. **Outcome of the course:** The students will revise their skills in basic programming and data structures. They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Quick overview on C language Pointers and arrays Linked lists Dynamic tables
	Unit 2	Disjoint sets using trees Hashing by chaining Perfect hashing Heaps using trees Search algorithms for graphs (DFS & BFS)
Component 2	Unit 3	Balanced trees B-tree Kruskal's algorithm Eulerian path Hamiltonian cycle
	Unit 4	Shell scripts in Linux environment Programming in bash and whiptail Automatic testing using shell scripts

6. **Text Book:**
7. **References:**
   a. C Programming Language (Ed 2) by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall
   b. Data Structures Using C and C++ by Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Pearson
   c. Introduction to Algorithms (Ed 3) by TH Cormen, CE Leiserson, RL Rivest and C Stein, MIT Press
   d. Pro Bash Programming by Chris F.A. Johnson, Apress

Course Syllabus A Templzate

1. **Name of the Course:** Advanced Data Structures and Algorithms
2. **LTP structure of the course:** 2-1-1
3. **Objective of the course:** To covers analysis and design of data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.
4. **Outcome of the course:** Students successfully completing this course will be able to:
   - Explain the need for efficiency in data structures and algorithms.
   - Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and implementations.
   - Understand and apply the concept of abstract data type to represent and implement heterogeneous data structures.

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Data StructuresIntroduction to Computing complexity of operations on data structuresLinear Data Structures : Stacks, Queues, Circular Queues Array-Based and Linked List based representation
	Unit 2	Binary Trees and Search Trees Scapegoat Trees Red-Black Trees
Component 2	Unit 3	Sets and Their representations Operations on Sets Strings : Representation and operations Compression and Encoding
	Unit 4	Graphs: Representation and Traversal Graph Algorithms : All source shortest paths, Transitive closure Max-flow - Min-Cut

6. **Text Book:**
7. **References:**
   a. Data Structures Using C and C++ by *Yedidyah Langsam, Moshe J. Augenstein* and *Aaron M. Tenenbaum*, Pearson
   b. Introduction to Algorithms (Ed 3) by *TH Cormen, CE Leiserson, RL Rivest* and *C Stein*, MIT Press
   c. Algorithms + Data Structures = Programs by Niklaus Wirth, PHI Learning

Course Syllabus A Template

1. **Name of the Course: Research Methodology**
2. **L TP structure of the course: 2-1-1**
3. **Objective of the course:** Core course for Ph.D. students
4. **Outcome of the course:** Learning to conduct research properly
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Research attitude &Choosing research problem	Chapter number from the text book may be given
	Unit 2	Different types of scientific writing (thesis, paper, review, proposal, popular article)	Chapter number from the text book may be given
Component 2	Unit 3	Communicating Science (research journalism, lecture, poster)	Chapter number from the text book may be given
	Unit 4	IPR, Plagiarism, use of computers, search engines, language and grammar	Chapter number from the text book may be given

6. **Text Book:** Mandatory for UG core courses
7. **References:**

Syllabus

1. **Name of the Course:** Cognition and Cognitive Process Modeling
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   a. To provide an overview of cognition in human brain.
   b. To introduce students about several AI debates and pro and against arguments of realization of true AI.
   c. To provide comprehensive details about the cutting-edge approaches and recent developments of cognitive systems.
   d. Introducing students about several cognitive architectures and hand-on working in these architectures.
4. **Outcome of the course:**
   a. Students will get the understanding of how human cognition works as per the explanations till date.
   b. Students will get new side of AI development(Using cognitive architectures).
   c. Students will get to know the challenges which have been accomplished and which is yet to be addressed to make true AI systems.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction**Human Brain: Introduction, cognitive faculties: memory, attention, vision and language, What is cognition, introduction about approaches to cognition, theories of mind: mind - body dualism, materialist theory of mind, identity theory of mind, computational theory of mind.
	Unit 2	**Consciousness and Free Will**Consciousness: First person approach , third person approach, Chalmers view of consciousness, problem of third person approach, Pattern-Information duality, Free Will: Sloman view, free will as continuous dimension, design distinctions for agent modeling.
Component 2	Unit 3	**AI Debates**First AI Debate: Is AI possible? Pro: Roger Penrose, moravec, Herbert Simon. Artificial mind via symbolic AI, Turing test of AI. Against: Dreyfus five stages of learning, Searle's chinese room thought experiment, Degrees of understanding, godel's incompleteness theorem Second AI Debate: Connectionist Model, Objectives of Connectionist model, Feldman's hundred step rules, Brain vs computer model of mind, Lloyd's cautions, Fodor's attack, Chamlmers' defense, Rule based AI.
	Unit 4	**Cognitive Architectures**ACT-R, CLARION, SOAR, Reinforcement Learning, Distributed Cognition, Learning and Memory Architectures. **Projects** 1. Hands-on on cognitive architectures. 2.Analysis of cognition of brain using complex networks.

Books:

1. Artificial Mind by Stan Franklin
2. Siegelbaum, Steven A., and A. J. Hudspeth. Principles of neural science. Eds. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Vol. 4. New York: McGraw-hill, 2000.
3. Research papers for brain modeling.

1. **Name of the Course: Image and Video Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   - To provide the basic understanding of the digital image formation and visualization.
   - To provide the visualization of relationships between spatial and frequency.
   - To provide the understanding of mapping the signal processing techniques to the digital image.
   - To provide an idea of multimedia data (image, video).
   - To provide an exposure to various image and video compression standards.
4. **Outcome of the course:**
   1. The students shall be able to apply the knowledge gained during the course to solve various real time problems.
   2. The students shall be able to develop new state of the art image and video processing method.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Digital Image Fundamentals Simple image model, digital image ormation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images. Color Image Processing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement Point Processing: Contrast Stretching, Power law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching.
	Unit 2	Filtering and Restoration Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and Nonlinear Filters: Mean and Median Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High boost Filtering. Frequency Domain Filtering: Filtering: Low pass (Smoothing) & High Pass (Sharpening) Ideal, Butterworth and Gaussian Filtering, Unsharp Masking and High Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.
Component 2	Unit 3	Edges, Lines and Boundary Detection First and Second Order Edge Operators, Multi scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection, Morphological Operations and Application: Boundary, Skelton Convex Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm.
	Unit 4	Compression: Lossy and Lossless compression techniques, JPE JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

6. **Text Book:** Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons
7. **Reference:**

Syllabus

1. **Name of the Course: Computer Vision**
2. **Objective of the course:**
   To provide an overview of how human brain does vision processing.
   To give an introduction about modeling aspect of low-level, intermediate level visual processing: Neuromorphic vision computing
   To give a perspective of machine vision through single camera and stereo vision technologies.
   To give an intuition about machine modeling of 3D structure, motion, activity and so on.
   Brain inspired modeling of high level vision processing such as object recognition, face recognition, activity analysis and so on.
3. **Outcome of the course:**
   a. Students will learn basics of stereo vision and algorithms.
   b. Students will get glimpse of efficiency of human brain vision.
   c. Students will get new perspective of brain inspired computational vision.
   d. Students will be able to look at the world in the form of matrices and model the activity happening in world reference frame
   e. By doing projects they will be able to apply the grabbed knowledge to real problems.
4. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction**Human Vision and Computer Vision ; Eye and Brain; Low, Intermediate and High level Vision processes; Historical Perspectives, Theoretical approaches to Visual Perception and Processing; Visual Illusions; Structuralism, Gestaltism, Ecological Optics and Constructivism; Marr's 2.5 D Sketch; Color Perceptionand Processing, neuromor phiccomputing
	Unit 2	Viewing through Camera;Multiview Geometry Camera, Image and World Reference Frames; Views and Coordinates Transformations: Orthogonal, Euclidean, Affine, Projective; Camera Calibration. Perspective, and Epipolar Geometry, Binocular Stereopsis, Homography, Rectification, DLT,RANSAC, Depth Map and 3D reconstruction framework, Depth Estimation, stitching.
Component 2	Unit 3	High Level one Vision Processing Understanding images and scenes, Four Stages of Visual Perception, Feature level Processing (Edges, Lines, Corners), Surfaces Extraction; Segmentation and Classification; Representations and Organizations of Objects and Scenes; 3D Scene Analysis; Size and Shape Constancy and Illusions; Using knowledge and learning for Object and Scene Recognition, Brain Inspired High level vision computing, Simulation of Visual Attention and Visual Memory Processes. Shape from X and Motion AnalysisLight at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, Shape from Texture, color, motion and edges. Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo, Motion parameter estimation; Motion Models and Analysis; Rigid and Non – Rigid Body Motion; Self Motion, Gesture and activity recognition.
	Unit 4	1. Projects on applying computer vision algorithms to the real world problem 2. Modeling of brain inspired vision solutions and applying these solutions to solve problems.

Books: Computer Vision: Algorithms and Applications, Richard Szeliski, Springer-Verlag London Limited 2011.
1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003. Vision Science : Photons to Phenomenology, MIT Press, Cambridge, 1999.
2. Handbook of Computer Vision, Vol.1, Vol.2, Vol.3 : Bernd Jahne, Horst Haubecker, and Peter Geibler (Eds.), Academic Press, London, 1999.
3. Siegelb aum, Steven A., and A. J. Hudspeth. Principles of neural science. Eds. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. Vol. 4. New York: McGraw-hill, 2000.
4. Purves, D. et al (2008) Neuroscience 4th edition. Sinauer Associates, Sunderland, MA

Course Syllabus

1. **Name of the Course: Soft Computing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To impart skill in the areas of Machine Learning
4. **Outcome of the course:** To enable students to face the challenges in the area of Machine Learning in the industry with sufficient confidence and enable researchers to develop new concepts in this exciting area.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to learning-intelligence vs autonomy; statistical learning theory, regression analysis, Feature scaling and regularization principle, representing large data with PCA & LDA, concept of recognition, distance based classification. (10 Lectures)
	Unit 2	Artificial Neural network-single layer perceptron, multilayer perceptron, Radial-Basis Function network, accelerated learning in multilayer networks, Hopfield network, Bidirectional Associative Memory, Self Organizing Map, Support Vector Machine, Stochastic Machines- Gibbs sampling, Restricted Boltzman Machine and Deep learning. (20 Lectures).
Component 2	Unit 3	Introduction to Fuzzy logic-Fuzzy thinking, Fuzzy sets, Linguistic variables and hedges, Operations of Fuzzy sets, Fuzzy rules, Fuzzy inference, Building a Fuzzy intelligent system, Basics of neuro –fuzzy system. (10 Lectures)
	Unit 4	Evolutionary Computation-simulation of natural evolution, Genetic algorithm, schema theory, hybrid intelligent system. (5 Lectures).

This is an elective course and a number of reference books and research articles will be followed.
Name of some books are given below:

Reference Books:

1. Introduction to Artificial Intelligence (A guide to Intelligent Systems) by Michael Negnevitsky, Addison Wesley publisher.
2. Neural Networks A comprehensive Foundation by Simon Haykin
3. Fuzzy Logic Intelligence, control, and information by John Yen, Reza Langari. Pearson
4. Genetic Algorithm by D E Goldberg

Course Syllabus

1. **Name of the Course: Convex Optimization**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** The course aims to introduce students to modern convex optimization and its applications in fields such as machine learning. The course is designed to cover practical modelling aspects, algorithm analysis and design, and the theoretical foundations of the subject. The focus however is on topics which might be useful for machine learning researchers.
4. **Outcome of the course:** On completion of the course, students should be able to recognize and formulate convex optimization problems as they arise in practice; know a range of algorithms for solving linear, quadratic and semi definite programming problems, and evaluate their performance; understand the theoretical foundations and be able to use it to characterise optimal solutions to optimization problems in Machine Learning.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Convex Analysis: Convex Sets, Convex Functions, Calculus of convex functions Optimality of Convex Programs: 1st order nec. and suff. conditions, KKT conditions Duality: Lagrange and Conic duality
	Unit 2	Standard Convex Programs and Applications Linear and Quadratic Programs Conic Programs: QCQPs, SOCPs, SDPs.
Component 2	Unit 3	Optimization Techniques Smooth Problems: Gradient descent, Stochastic gradient descent, Newton's methods, Interior Point method. Nonsmooth Problems: Sub-gradient descent
	Unit 4	Active set and cutting planes methods Online convex optimization Beyond convex optimization: Examples and challenges. Sequential Convex Optimization.

6. **Text Book:**

S.Boyd and L.Vandenberghe. Convex Optimization. Cambridge University Press, 2004. Available at http://www.stanford.edu/~boyd/cvxbook/

7. **References:**

R.T.Rockafellar. Convex Analysis. Princeton University Press, 1996.

A.Nemirovski. Lectures On Modern Convex Optimization (2005). Available at

www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf

Y.Nesterov. Introductory Lectures on Convex Optimization: A Basic Course. Kluwer Academic Publishers, 2004

Syllabus

1. **Name of the Course: Information Retrieval**
2. **Objective of the course:**
   a. To provide an overview of Information Retrieval.
   b. To introduce students about insights of the several topics of Information retrieval such as – Boolean retrieval model, Vector space model, Latent semantic indexing, XML and Image retrieval model.
   c. To provide comprehensive details about various Evaluation methods.
   d. To provide implementational insight about the topics covered in the course.
3. **Outcome of the course:**
   a. Students will get the understanding different Information retrieval model.
   b. Students will get to know about evaluation methods of the information retrieval model.
   c. Students will get to know the challenges associated with each topic.
4. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1 Component 2	Unit 1	Introduction to Information retrieval Information retrieval process, Indexing, Information retrieval model, Boolean retieval model Dictionary and Postings Tokenization, Stop words, Stemming, Inverted index, Skip pointers, Phrase queries
		Tolerant Retrieval Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Jaccard coefficient, Soundex Term Weighting and Vector Space Model Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Jaccard coefficient, Soundex
	Unit 2	Evaluation Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems Latent Semantic Indexing Eigen vectors, Singular value decomposition, Low-rank approximation, Problems with Lexical Semantics Query Expansion
	Unit 3	Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query driftProbabilistic Information Retrieval Probabilistic relavance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval
	Unit 4	XML Indexing and Search Data vs. Text-centric XML, Text-Centric XML retrieval, Structural terms Content Based Image Retrieval Introduction to content Based Image retrieval, Challenges in Image retrieval, Image representation, Indexing and retrieving images, Relevance feedback.

5. **Books:** Introduction to Information Retrieval by Christopher D. Manning
   Natural Language Processing And Information Retrieval by *Tanveer Siddiqui and U. S. Tiwary*

Course Syllabus

1. **Name of the Course: Natural Language Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course provides an introduction to the field of computational linguistics, aka natural language processing (NLP). The course will cover linguistic (knowledge-based) and statistical approaches to language processing in the three major subfields of NLP: syntax (language structures), semantics (language meaning), and pragmatics/discourse (the interpretation of language in context).
4. **Outcome of the course:** Students will learn how to create systems that can understand and produce language, for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialogue systems.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	IntroductionN-Gram Models
	Unit 2	Parts of Speech Tagging and Sequence LabellingBasic of ANN and Recurrent Neural Network
Component 2	Unit 3	Syntactic Parsing Semantic Analysis
	Unit 4	Information ExtractionMachine Translation

6. **References:**

1. Jurafsky and Martin, *SPEECH and LANGUAGE PROCESSING: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition*, McGraw Hill, 2008. Daphne Koller and Nir Friedman, **Probabilistic Graphical Models: Principles and Techniques**
2. **Recommended Supplementary Text:** Manning and Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: 1999.
3. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.

Course Syllabus

1. **Name of the Course: Pattern Recognition**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course deals with pattern recognition, which has several important applications. For example, multimedia document recognition (MDR) and automatic medical diagnosis are two such.
4. **Outcome of the course:** Students will learn Pattern Recognition techniques and its applications.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Preliminary concepts and pre-processing phases, coding, normalization, filtering, linear prediction, Feature extraction and representation thresholding, contours, regions, textures, template matching
	Unit 2	Data structure for pattern recognition, statistical pattern recognition, clustering Technique and application. Study of pattern classifiers: Supervised and unsupervised.
Component 2	Unit 3	Pattern Classifiers: Naïve Bayes, Linear Discriminant Analysis, k- nearest neighbour (K-NN), Artificial Neural Network etc. and Case studies
	Unit 4	Application: Finance, Multimedia.

6. **References:**

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. K. Fukunaga, Statistical pattern Recognition; Academic Press, 2000.
3. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011

Course Syllabus:

1. **Name of the Course: Advanced data analytics**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Talks about domain specific mining issues and methods. Large data mining
4. **Outcome of the course:** Students will get exposure of various methods of performing data mining.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Association mining, Classification andClustering : Revision.Data Streams mining, Social NetworkAnalysis, Graph mining
	Unit 2	Mining algorithms for large data, MiningBig Data, Hadoop, Map-Reduce, HDFS,Spark + seminars
Component 2	Unit 3	Mining Sequence pattern in TD, MiningTime-series data, , Mining WWW +seminars
	Unit 4	Advanced Machine Learning: DeepLearning, probabilistic learning + seminars

6. **Text Book:** Mandatory for UG core courses (There is no one book to be prescribed as Text book as advance topics will be covered from different book along with research papers.
7. **References:**

Jiawei Han Micheline Kamber Jian Pei “Data Mining: Concepts and Techniques” 3rd Edition, 2011

Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.

Hadzic F., Tan H. & Dillon T. S. “Mining data with Complex Structures” Springer, 2011

Yates R. B. and Neto B. R. “Modern Information Retrieval ” Pearson Education, 2005

Ian Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”

1. **Name of the Course: Biometrics**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Students will get of an overview of human biometrics.
4. **Outcome of the course:** Students will get glimpse of efficiency of human biometric.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Biometrics Overview (History of Biometrics, Applications), Performance Evaluation / Biometric System Design Challenges, Biometric traits and its aim, image processing basics, basic image operations, Filtering, enhancement, sharpening, edge detection, smoothening, enhancement, Thresholding, localization.
	Unit 2	Fingerprint Recognition, Face Recognition, Iris Recognition, Hand Shape Recognition, Voice Recognition,
Component 2	Unit 3	Multi-modal Biometric Systems, Biometric System Security, Identity Science Technology (If time permits)
	Unit 4	State of the art methods in biometrics, Biometric Deep Architectures, Ethical and social implications of biometric identification technology and Projects.

1. Text Book: Introduction to Biometrics, Jain, Anil, Ross, Arun A., Nandakumar, Karthik
2. Reference:
   - IEEE Transactions on Information Forensics
   - IEEE Transactions on Image Processing
   - IET Biometrics
   - IET Image Processing

Course Syllabus

1. **Name of the Course: Probabilistic Machine Learning and Graphical Models**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Introduce probabilistic view on machine learning and discuss graphical models with Mathematical rigour and application in real problems. This course will make extensive use of probability, statistics, and optimization.
4. **Outcome of the course:** Student will understand about probabilistic machine learning and get exposer to current cutting edge research. After successfully attending the course, students have developed an in-depth understanding of probabilistic graphical models. They describe and analyze properties of graphical models, and formulate suitable models for concrete estimation and learning tasks. They understand inference algorithms, judge their suitability and apply them to graphical models in relevant applications.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Probabilistic supervised learning.
	Unit 2	Probabilistic Unsupervised learning
Component 2	Unit 3	Graphical Model representation, including Bayesian and Markov networks, and dynamic Bayesian networks..
	Unit 4	Probabilistic inference algorithms, both exact and approximate; Sampling; and learning methods for both the parameters and the structure of graphical models

6. **References:**

1. Kevin Murphy, "Machine learning: a probabilistic perspective", MIT Press, 2012.
2. Daphne Koller and Nir Friedman, **Probabilistic Graphical Models: Principles and Techniques**
3. Michael I. Jordan, **An Introduction to Probabilistic Graphical Models,** in preparation. **Course2:**

Course Syllabus

1. **Name of the Course: Virtual Reality**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**

   Virtual Reality (VR) is changing the interface between people and information technology by offering new ways for the communication of information, the visualization of processes, and the creative expression of ideas. The course objective is to promote the understanding of this technology, underlying principles, its potential and limits and to learn about the criteria for defining useful applications. Furthermore, each student will be exposed to the process of creating virtual environments, by developing a complete VR or Augmented Reality (AR) application as members of a small team.

4. **Outcome of the course:**

   The students will learn a ton about Virtual and Augmented Reality, get familiar with the latest technology, techniques and software, and build an application during the course. There will also be seminar presentations on research topics/articles (published in reputed journals/ advanced books) related with VR/AR by the postgraduate students.

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction, Components of a VR system, 3D User Interface Input and Output devices, 3D viewing, Designing & Building VR Systems, Introduction to Augmented Reality (AR),
	Unit 2	VR Modeling: Geometric modeling, Kinematic, Physical and Behavior modeling; Selection and Manipulation during 3D Interaction,
Component 2	Unit 3	Travel and Wayfinding in Virtual Environments, Strategies for Designing and Developing 3D UIs, Evaluation of 3D User Interfaces, Traditional and Emerging VR/AR applications,
	Unit 4	Human Factors in Virtual Reality, Case study on Construction of Geographic Virtual World. Group assignments on implementation of a Virtual/ Augmented Reality Application using open-source toolkits/ libraries such as OpenSceneGraph, Vega, VRML etc.

6. **Text/ Reference Books:**

1. G.C. Burdea & P. Coiffet, “Virtual reality Technology, Second Ed.”, Wiley-India.
2. GJ Kim, “Designing VR Systems: The Structured Approach”, Springer.
3. D.A. Bowman et al., “3D User Interfaces: Theory and Practice”, Addison Wesley.
4. John Vince, “Virtual Reality Systems”, Pearson Ed.
5. Rick Parent, “Computer Animation: Algorithms & Techniques”, Morgan Kaufmann.

7. **References (papers from major conferences/journals):**

- SIGGRAPH
- Symposium on Computer Animation (SCA)
- Eurographics
- ACM Trans on Graphics

Course Syllabus for Deep Learning

1. **Name of the Course: Deep Learning**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To get the students and researchers exposed to the state of the art deep learning techniques, approaches and how to optimize their results to increase its efficiency and get some hands-on on the same to digest the important concepts.
4. **Outcome of the course:** As deep learning has demonstrated its tremendous ability to solve the learning and recognition problems related to the real world problems, the software industries have accepted it as an effective tool. As a result there is a paradigm shift of learning and recognition process. The students and researchers should acquire knowledge about this important area and must learn how to approach to a problem, whether to deal with deep learning solution or not. After undergoing this course they should be able to categorize which algorithm to use for solving which kind of problem. Students will be able to find out the ways to regularize the solution better and optimize it as per the problem requirement. Students will be exposed to the background mathematics involved in deep learning solutions. They will be able to deal with real time problems and problems being worked upon in industries. Taking this course will substantially improve their acceptability to the machine learning community – both as an intelligent software developer as well as a matured researcher.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basic concepts of perceptron, learning and recognition- supervise and unsupervised learning. Fundamentals of delta learning rules and back propagation algorithm, SVM, KNN. Machine Learning, machine learning techniques, challenges motivating deep learning. over fitting and under fitting, bias and variance, Gradient based optimization, Maximum Likelihood Estimation. Deep Feed-forward network, back propagation. Some Regularization and Optimization Techniques
	Unit 2	Convolutional Neural Network, RNN, methodology and Applications of deep learning Linear Factor Models and Autoencoders
Component 2	Unit 3	Monte Carlo Methods, Stochastic Maximum, Likelihood and Contrastive Divergence
	Unit 4	Deep Generative Models: Boltzmann Machine, RBM, Deep Belief Nets, Deep Boltzmann Machine, Convolutional Boltzmann Machine

6. **Text Book:**

   Deep Learning by- Ian Good fellow, Yoshua Bengio and Aaron Courville

   In addition other machine learning books , research papers etc. will be used.

1. **Name of the Course: Introduction to Machine Learning**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course gives an introduction to machine learning. It is about unified understanding of the models and algorithms used in machine learning.
4. **Outcome of the course:** Students will be able to understand basic concept and they will be able to successfully apply it on real data set.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Decision Trees and K-Nearest-Neighbors, Linear and Ridge Regression, Perceptron, Support Vector Machines (SVM), Kernels and nonlinear SVMs,
	Unit 2	Model Selection, Feature Selection. Ensemble Methods. Hierarchical and Flat Clustering, Gaussian Mixture Models, Linear Dimensionality Reduction
Component 2	Unit 3	Matrix Factorization, Nonlinear Dimensionality Reduction and Manifold Learning.
	Unit 4	Artificial Neural Network (Forward/Back propagation); Reinforcement Learning and Hidden Markov Model.

6. **Text Book:** Christopher Bishop, "Pattern recognition and machine learning", Springer, 2007.Richard
7. **References:**

1. Duda, Peter Hart, David Stork, "Pattern Classification", Wiley; Second edition
2. Tom Mitchell, "Machine Learning".
3. Hal Daumé III, A Course in Machine Learning (http://ciml.info), 2015
4. Kevin Murphy, "Machine learning: a probabilistic perspective", MIT Press, 2012.

M.Tech (IT) with Specialization in R.M.I.

6. M.Tech (IT) with specialization in Machine Learning and Intelligent Systems

First Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematics for IT	4	2	2	0	HC
2.	Programming Practices	4	2	0	2	HC
3.	Advanced Data Structures and Algorithms	4	2	1	1	HC
4.	Research Methodology	4	2	1	1	HC
	Total	16	24 Hrs.			

Second Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematical Foundations of Robotics-1	4	2	0	2	HC
2.	Robot Motion Control	4	2	1	1	HC
3.	Soft Computing	4	2	1	1	HC
4.	Elective-1	4	2	1	1	
5.	Project -1	4	0	1	3	
	Total	20	32 Hrs.			

Thrid Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Mathematical Foundation of Robotics-2	4	2	1	1	
2.	Elective -3	4	2	1	1	
3.	Elective - 4	4	2	1	1	
4.	Thesis	6	0	1	5	
	Total	18	30 Hrs.			

Fourth Semester

S.No.	Subject Name	Total Credit	L	T	P	
1.	Thesis	10	0	1	8	
	Total	10	20 Hrs.			

List of Electives :

1. Biped locomotion and Control	2. Natural Language Processing	3. Distributed Systems
4. Swarm and Evolutionary Robotics	5. Deep Learning	6. Social Network Analysis
7. Robot Motion Planning	8. Embedded Systems	9. Computer Vision
10. Human Robot Interaction	11. Virtual Reality	11. Advanced Robotics perception and control
12. Image and Video Processing		

HEAD
Department of Information Technology
Indian Institute of Information Technology
Allahabad

Course Syllabus

1. **Name of the Course: Mathematics for IT**
2. **LTP structure of the course: 2-2-0**
3. **Objective of the course:** This course covers Linear algebra; Matrix theory and discrete probability for information technology. Objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving.
4. **Outcome of the course:** Students will learn fundamentals and able to apply these knowledge in practical problems.
5. **Course Plan:**

Component	Unit		Topics for Coverage
Component 1	Unit 1	**Linear Algebra**	Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Subspaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties
	Unit 2		Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition
Component 2	Unit 3	**Discrete Probability**	Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation
	Unit 4		Limit Theorems, Deviations; Markov Chains; Random Walks

6. **Text Book:**
   1. Strang, Gilbert. Introduction to Linear Algebra.
   2. Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability.

Course Syllabus A Template

1. **Name of the Course: Programming Practices**
2. **LTP structure of the course: 2-0-2**
3. **Objective of the course:** To revise basic programming skills and coding data structures for PG (IT) students.
4. **Outcome of the course:** The students will revise their skills in basic programming and data structures. They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Quick overview on C languagePointers and arraysLinked listsDynamic tables
	Unit 2	Disjoint sets using treesHashing by chainingPerfect hashingHeaps using treesSearch algorithms for graphs (DFS & BFS)
Component 2	Unit 3	Balanced treesB-treeKruskal's algorithmEulerian pathHamiltonian cycle
	Unit 4	Shell scripts in Linux environmentProgramming in bash and whiptailAutomatic testing using shell scripts

6. **Text Book:**
7. **References:**
   a. C Programming Language (Ed 2) by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall
   b. Data Structures Using C and C++ by Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Pearson
   c. Introduction to Algorithms (Ed 3) by TH Cormen, CE Leiserson, RL Rivest and C Stein, MIT Press
   d. Pro Bash Programming by Chris F.A. Johnson, Apress

Course Syllabus A Template

1. **Name of the Course: Advanced Data Structures and Algorithms**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To covers analysis and design of data structures and engages learners to use data structures as tools to algorithmically design efficient computer programs that will cope with the complexity of actual applications.
4. **Outcome of the course:** Students successfully completing this course will be able to:
   - Explain the need for efficiency in data structures and algorithms.
   - Apply methods to analyze running time of essential data structures and estimate efficiency of the algorithms and iplementations.
   - Understand and apply the concept of abstract data type to represent and implement heterogeneous data structures.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Data StructuresIntroduction to Computing complexity of operations on data structuresLinear Data Structures : Stacks, Queues, Circular QueuesArray-Based and LinkedList based representation
	Unit 2	Binary Trees and Search TreesScapegoat TreesRed-Black Trees
Component 2	Unit 3	Sets and Their representationsOperations on SetsStrings : Representation and opertionsCompression and Encoding
	Unit 4	Graphs: Representation and TraversalGraph Algorithms : All source shortest paths, Transitive closureMax-flow - Min-Cut

6. **Text Book:**
7. **References:**
   a. Data Structures Using C and C++ by Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Pearson
   b. Introduction to Algorithms (Ed 3) by TH Cormen, CE Leiserson, RL Rivest and C Stein, MIT Press
   c. Algorithms + Data Structures = Programs by Niklaus Wirth, PHI Learning

Course Syllabus A Template

1. **Name of the Course: Research Methodology**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** Core course for Ph.D. students
4. **Outcome of the course:** Learning to conduct research properly
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Research attitude &Choosing research problem	Chapter number from the text book may be given
	Unit 2	Different types of scientific writing (thesis, paper, review, proposal, popular article)	Chapter number from the text book may be given
Component 2	Unit 3	Communicating Science (research journalism, lecture, poster)	Chapter number from the text book may be given
	Unit 4	IPR, Plagiarism, use of computers, search engines, language and grammar	Chapter number from the text book may be given

6. **Text Book:** Mandatory for UG core courses
7. **References:**

Course Syllabus

1. **Name of the Course: Robot Motion Planning**
2. **LTP structure of the course: 3-0-1**
3. **Objective of the course:** The course enables the students learn the basics of mobile robotics and helps them understand the mechanisms to plan and navigate different types of robots from a pre-specified source to a pre-specified goal using a variety of Artificial Intelligence techniques.
4. **Outcome of the course:** From this course the students will be able to appreciate intelligent robotic systems involving single and multiple robots, get a good grasp in Artificial Intelligence tools and techniques from an application point of view, and be able to plan for different robots in different conditions and constraints.
5. **Course Plan:**

Component	Unit	Topics for Coverage (Theory)	Topics for Coverage (Practice)	Chapter No. (Optional)
Component 1	Unit 1	Introduction, Configuration Spaces, Collision Detection, Bug Algorithms	Simple collision-checking for different types of robots in 2D workspaces	1, 2, 3
	Unit 2	A* Algorithm and Roadmap Based Approach	Constructing 2D configuration spaces	5, H
Component 2	Unit 3	Sampling based Robotics, Cell-Decomposition proaches	OMPL installation and play-through	6, 7
	Unit 4	Optimization based planning, Hybrid Planning, Multi-Robot Motion Planning	Writing planners using OMPL	Selected research papers by the instructor

6. **Text Book:**

- H. Choset, K. M. Lynch, S. Hutchinson, G. A. Kantor, W. Burgard, L. E. Kavraki, S. Thrun (2005) Principles of Robot Motion: Theory, Algorithms, and Implementations, MIT Press, Cambridge, MA.
- 7. References:• S. M. LaValle (2006) Planning Algorithms, Cambridge University Press, NY.

  • R. Kala (2016) On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems,Elsevier, Waltham, MA

Course Syllabus

1. **Name of the Course: Natural Language Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** This course provides an introduction to the field of computational linguistics, aka natural language processing (NLP). The course will cover linguistic (knowledge-based) and statistical approaches to language processing in the three major subfields of NLP: syntax (language structures), semantics (language meaning), and pragmatics/discourse (the interpretation of language in context).
4. **Outcome of the course:** Students will learn how to create systems that can understand and produce language, for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialogue systems.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction N-Gram Models
	Unit 2	Parts of Speech Tagging and Sequence Labelling Basic of ANN and Recurrent Neural Network
Component 2	Unit 3	Syntactic Parsing Semantic Analysis
	Unit 4	Information ExtractionMachine Translation

6. **References:**

1. Jurafsky and Martin, *SPEECH and LANGUAGE PROCESSING: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition*, McGraw Hill, 2008. Daphne Koller and Nir Friedman, **Probabilistic Graphical Models: Principles and Techniques**
2. **Recommended Supplementary Text:** Manning and Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: 1999.
3. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.

1. **Name of the Course: Distributed Systems**
2. **LTP structure of the course: 3-0-1**
3. **Objective of the course:** To provide students the understanding of the principles on which the Distributed systems such as Internet are based; their architecture, algorithms and design
4. **Outcome of the course:**
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction :**Defining Distributed Systems, Goals and Challenges, Representation, Models of Distributed Systems **Architecture Models of computation:**Architecture Styles - Centralized and Decentralized architectural styles, Client-Server architecture - Application layering; Per to Peer Systems; **Middleware :**Message passing systems, synchronous and asynchronous systems; Remote procedure calls, Remote Method Invokation;
	Unit 2	**Clock and Causal Ordering :** Managing physical clocks in distributed systems; Logical clocks: Lamport's and vector clocks; Global state recording and Snapshot Algorithms; Clock synchronization, **OS concepts :**Distributed mutual exclusion - permission based algorithms, token based algorithms;
Component 2	Unit 3	**OS concepts :** Handling deadlocks; Event driven systems for asynchronous Distributed Systems; **Leader election; Waves and Traversal;** **Resourse management :**Distributed file systems; DFS examples: Hadoop; Distributed shared memory; Load distribution; Cloud computing, SOA;
	Unit 4	**Fault tolerance and recovery :** Fault models, agreement problems and its applications; Commit protocols, voting protocols; Check pointing and recovery, Multicast communication;

6. **Text Book:**

   George Coulouris Jean Dollimore, and Tim Kindberg, Distributed Systems: Concepts and Design

7. **References:**

   a. George Coulouris A.D. Kshemkalyani, M. Singhal, *Distributed Computing: Principles, Algorithms, and Systems,*
   b. Nancy Lynch; *Distributed Algorithms*, Morgan Kaufmann.
   c. Andrew S. Tanenbaum and Martan Van Steen, *Distributed Systems, Principles and Paradigms*
   d. Mukesh Singhal and Niranjan Shivaratri , *Advanced Concepts in Operating Systems*

Course Syllabus

1. **Name of the Course: Swarm and Evolutionary Robotics**
2. **LTP structure of the course: 3-0-1**
3. **Objective of the course:** The courses enables the students learn how atomic actions by simple robots can lead to display of complex robotic behaviors, and furthers the discussion by the showing the mechanisms of automatic generation of such simple actions using evolutionary computation.
4. **Outcome of the course:** Through this course the students will be able to understand how decentralized decision making can lead to solutions to complex problems through the example of robotic swarms. The students also reinforce their learning in evolution by taking the topic in the interesting application of evolution of robotic controllers.
5. **Course Plan:** As per the below format only

Component	Unit	Topics for Coverage (Theory)	Topics for Coverage (Practice)	Chapter No. (Optional)
Component 1	Unit 1	Introduction, Reinforcement Learning	Simulating simple roboticbehaviors	
	Unit 2	Reactive and Model based Robotic Behaviors, Swarm Robotics	Simulating collective and stochastic robotic behaviors	
Component 2	Unit 3	Simulation Software with examples from crowd and traffic simulation systems	Controlling a robot in Robot Operating System	
	Unit 4	Evolutionary Robotics	Displaying collective robot behaviors in robot operating	

6. **Text Book:**
   - Research papers and book chapters given by the instructor
7. **References:**

Course Syllabus for Deep Learning

1. **Name of the Course: Deep Learning**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:** To get the students and researchers exposed to the state of the art deep learning techniques, approaches and how to optimize their results to increase its efficiency and get some hands-on on the same to digest the important concepts.
4. **Outcome of the course:** As deep learning has demonstrated its tremendous ability to solve the learning and recognition problems related to the real world problems, the software industries have accepted it as an effective tool. As a result there is a paradigm shift of learning and recognition process. The students and researchers should acquire knowledge about this important area and must learn how to approach to a problem, whether to deal with deep learning solution or not. After undergoing this course they should be able to categorize which algorithm to use for solving which kind of problem. Students will be able to find out the ways to regularize the solution better and optimize it as per the problem requirement. Students will be exposed to the background mathematics involved in deep learning solutions. They will be able to deal with real time problems and problems being worked upon in industries. Taking this course will substantially improve their acceptability to the machine learning community – both as an intelligent software developer as well as a matured researcher.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basic concepts of perceptron, learning andrecognition- supervise and unsupervised learning. Fundamentals of delta learning rules and back propagation algorithm, SVM, KNN. Machine Learning, machine learning techniques, challenges motivating deep learning. over fitting and under fitting, bias and variance, Gradient based optimization, Maximum LikelihoodEstimation. Deep Feed-forward network, backpropagation. SomeRegularization and Optimization Techniques
	Unit 2	Convolutional Neural Network, RNN, methodology and Applications of deep learning
Component 2	Unit 3	Linear Factor Models and Autoencoders Monte Carlo Methods, Stochastic Maximum, Likelihood and Contrastive Divergence
	Unit 4	Deep Generative Models: Boltzmann Machine, RBM, Deep Belief Nets, Deep Boltzmann Machine, Convolutional Boltzmann Machine

6. **Text Book:**

   Deep Learning by- Ian Good fellow, Yoshua Bengio and Aaron Courville

   In addition other machine learning books , research papers etc. will be used.

Syllabus

1. **Name of the Course: Computer Vision**
2. **Objective of the course:**
   To provide an overview of how human brain does vision processing.
   To give an introduction about modeling aspect of low-level, intermediate level visual processing: Neuromorphic vision computing
   To give a perspective of machine vision through single camera and stereo vision technologies.
   To give an intuition about machine modeling of 3D structure, motion, activity and so on.
   Brain inspired modeling of high level vision processing such as object recognition, face recognition, activity analysis and so on.
3. **Outcome of the course:**
   a. Students will learn basics of stereo vision and algorithms.
   b. Students will get glimpse of efficiency of human brain vision.
   c. Students will get new perspective of brain inspired computational vision.
   d. Students will be able to look at the world in the form of matrices and model the activity happening in world reference frame
   e. By doing projects they will be able to apply the grabbed knowledge to real problems.
4. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction** Human Vision and Computer Vision ; Eye and Brain; Low, Intermediate and High level Vision processes; Historical Perspectives, Theoretical approaches to Visual Perception and Processing; Visual Illusions; Structuralism, Gestaltism, Ecological Optics and Constructivism; Marr's 2.5 D Sketch; Colo rPerception and Processing, neuromorphic computing.
Component 2	Unit 2	Viewing through Camera; Multiview Geometry Camera, Image and World Reference Frames;Views and CoordinatesTransformations: Orthogonal, Euclidean, Affine, Projective; Camera Calibration. Perspective, and Epipolar Geometry, Binocular Stereopsis, Homography, Rectification, DLT, RANSAC, Depth Map and 3D reconstruction frame work, Depth Estimation, stitching.
	Unit 3	High Level one Vision Processing Understanding images and scenes, Four Stages of Visual Perception, Feature level Processing (Edges, Lines, Corners), Surfaces Extraction; Segmentation and Classification; Representations and Organizations of Objects and Scenes; 3D Scene Analysis; Size and Shape Constancy and Illusions; Using knowledge and learning for Objec and Scene Recognition, Brain Inspired High level vision computing, Simulation of Visual Attention and Visual Memory Processes. Shape from X and Motion Analysis Light at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, Shape from Texture, color, motion and edges. Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo, Motion parameter estimation; Motion Models and Analysis; Rigid and Non – Rigid Body Motion; Self Motion, Gesture and activity recognition.
	Unit 4	1. Projects on applying computer vision algorithms to the real world problem 2. Modeling of brain inspired vision solutions and applying these solutions to solve problems.

Books: Computer Vision: Algorithms and Applications, Richard Szeliski, Springer-Verlag London Limited 2011.
1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
2. Vision Science : Photons to Phenomenology, MIT Press, Cambridge, 1999.
3. Handbook of Computer Vision, Vol.1, Vol.2, Vol.3 : Bernd Jahne, Horst
4. Haubecker, and Peter Geibler (Eds.), Academic Press, London, 1999.

Course Syllabus

1. **Name of the Course: Virtual Reality**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**
   Virtual Reality (VR) is changing the interface between people and information technology by offering new ways for the communication of information, the visualization of processes, and the creative expression of ideas. The course objective is to promote the understanding of this technology, underlying principles, its potential and limits and to learn about the criteria for defining useful applications. Furthermore, each student will be exposed to the process of creating virtual environments, by developing a complete VR or Augmented Reality (AR) application as members of a small team.
4. **Outcome of the course:**
   The students will learn a ton about Virtual and Augmented Reality, get familiar with the latest technology, techniques and software, and build an application during the course. There will also be seminar presentations on research topics/articles (published in reputed journals/ advanced books) related with VR/AR by the postgraduate students.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction, Components of a VR system, 3D User Interface Input and Output devices, 3D viewing, Designing & Building VR Systems, Introduction to Augmented Reality (AR),
	Unit 2	VR Modeling: Geometric modeling, Kinematic, Physical and Behavior modeling; Selection and Manipulation during 3D Interaction,
Component 2	Unit 3	Travel and Wayfinding in Virtual Environments, Strategies for Designing and Developing 3D UIs, Evaluation of 3D User Interfaces, Traditional and Emerging VR/AR applications,
	Unit 4	Human Factors in Virtual Reality, Case study on Construction of Geographic Virtual World. Group assignments on implementation of a Virtual/ Augmented Reality Application using open-source toolkits/ libraries such as OpenSceneGraph, Vega, VRML etc.

6. **Text/ Reference Books:**
   1. G.C. Burdea & P. Coiffet, "Virtual reality Technology, Second Ed.", Wiley-India.
   2. GJ Kim, "Designing VR Systems: The Structured Approach", Springer.
   3. D.A. Bowman et al., "3D User Interfaces: Theory and Practice", Addison Wesley.
   4. John Vince, "Virtual Reality Systems", Pearson Ed.
   5. Rick Parent, "Computer Animation: Algorithms & Techniques", Morgan Kaufmann.
7. **References (papers from major conferences/journals):**
   - SIGGRAPH
   - Symposium on Computer Animation (SCA)
   - Eurographics,ACM Trans on Graphics

1. **Name of the Course: Image and Video Processing**
2. **LTP structure of the course: 2-1-1**
3. **Objective of the course:**

- To provide the basic understanding of the digital image formation and visualization.
- To provide the visualization of relationships between spatial and frequency.
- To provide the understanding of mapping the signal processing techniques to the digital image.
- To provide an idea of multimedia data (image, video).
- To provide an exposure to various image and video compression standards.

4. **Outcome of the course:**
   1. The students shall be able to apply the knowledge gained during the course to solve various real time problems.
   2. The students shall be able to develop new state of the art image and video processing method.
5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1 Component 2	Unit 1	Digital Image Fundamentals Simple image model, digital image formation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images. Color Image Processing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement Point Processing: Contrast Stretching, Power law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching.
	Unit 2	Filtering and Restoration Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and Nonlinear Filters: Mean and Median Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High boost Filtering. Frequency Domain Filtering: Filtering: Low pass (Smoothing) & High Pass (Sharpening) Ideal, Butter worth and Gaussian Filtering, Unsharp Masking and High Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.
	Unit 3	Edage Lines and Boundary Detection First and Second Order Edge Operators, Multi scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection Morphological Operations and Application: Boundary, Skelton, Convex Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm.
	Unit 4	Compression: Lossy and Lossless compression techniques, JPEG JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

6. **Text Book:** Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons

7. **Reference:**