Indian Institute of Information Technology, Allahabad

Department of Information Technology

UG curriculum

(With effect from July 2018)

Syllabus

SEMESTER-1

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Name of the Course: Engineering Physics (IT/ECE)

2. LTP structure of the course: 2-1-1

3. Objective of the course: To let the first year B. Tech. (ECE) students exposed to basic laws of nature and to demonstrate their application on physical systems and technical devices.

4. Outcome of the course: The students will learn how to handle dynamics of simple systems like point particle. Students will be exposed to laws of physics in the atomic or sub-atomic regime. Mathematical tools that the students will learn in this course will be highly beneficial for the students to explore many areas of engineering stream including: Quantum computation, Electronics, Semiconductor Devices and technology etc.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	1	Classical Mechanics: Calculus of Variations; Lagrange's Equations; Hamilton's principle, Hamilton's equations of motion, Applications.
	2	Heisenberg Uncertainty Principle, Wave Function, its Interpretation and Normalization; Superposition of Amplitudes, Dynamical Variables as Operators; Expectation Values, Schrodinger Equation and its Simple Applications like Particle in a Box, Quantum Well, Potential Barrier Problem, Electron in periodic potential and band structure of solid, k-space.
Component 2	3	Semiconductors: Introduction, Energy Bands in conductors, semiconductors, insulators, intrinsic and extrinsic semiconductor, and Carrier transport in semiconductor: diffusion current, drift current, mobility and resistivity. Generation and recombination of carriers in semiconductors. Thermal Noise, Shot Noise. Electrons and Holes in semiconductors: Silicon crystal structure, Donors and acceptors in the band model, electron effective mass, Density of states, Thermal equilibrium, and Fermi-Dirac distribution function for electrons and holes, Fermi energy. Equilibrium distribution of electrons & holes. The n-p product and the intrinsic carrier concentration at extremely high and low temperatures, Variation of Fermi energy with doping concentration and temperature
	4	Motion and Recombination of Electrons and Holes: Carrier drift: Electron and hole motilities, Mechanism of carrier scattering, Drift current and conductivity. Carrier diffusion: diffusion current, Total current density, relation between the energy diagram and potential, electric field, Einstein relationship between diffusion coefficient and mobility

6. Text Book:

Classical Mechanics:

Classical Mechanics; H. Goldstein, C. Poole, J. Safko.

Quantum Mechanics:

Introduction to Quantum Mechanics by D . J. Griffiths

Modern Physics by A. Beiser.

Solid State Physics

Physics of semiconductor devices, S M Sze, John Wiley & Sons, 2006.;

7. References:

L.D. Landau and E.M. Lifshitz, Mechanics.

Theoretical Mechanics by M. Spiegel.

Feynman Lectures of Physics Vol-1 and Vol-3.

Quantum Physics for Atoms, Molecules, Solids, Nuclei and Particles by R Eisberg and R. Resnick.

Integrated Electronics: Analog and Digital Circuits and Systems by J. Millman and C.C. Halkias.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1**. Name of the Course:** Linear Algebra

2. **LTP structure of the course:** 3-1-0

3. **Objective of the course:** Solving systems of linear equations, Understanding vector spaces, linear transformations, eigenvalue, eigenvector, generalized notion of angle, distance, and length, diagonalization and orthogonalization.

4.**Outcome of the course:** To able to solve systems of linear equations, work within vector spaces, to manipulate matrices and to do matrix algebra.

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	System of linear equation, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordon method for finding inverse of a matrix, Determinant, Cramer's rule, Vector spaces, Linearly independence and independence, Basis, Dimension
	Unit 2	Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeneous equations, Inner product space, Cauchy-Schwartz inequality, Orthogonal basis,
Component 2	Unit 3	Grahm-Schmidt orthogonalization process, Orthogonal projection, Eigen value, eigenvector, Cayley-Hamilton theorem, Diagonalizability and minimal polynomial, Spectral theorem,
	Unit 4	Positive, negative and semi definite matrices. Decomposition of the matrix in terms of projections, Strategy for choosing the basis for the four fundamental subspaces, Least square solutions and fittings, Singular values, Primary decomposition theorem, Jordan canonical form

6. **Text Book:** Gilbert Strang, Linear Algebra, Cambridge Press.

7. **References Books:**

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson.

2. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India.

3. S. Lang, Introduction to Linear Algebra, Springer

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Introduction to Programming

2. LTP structure of the course: L: 2 T:1 P: 1

3. Objective of the course: The purpose of this course is to provide the basic knowledge of C programming

4. Outcome of the course: The students will be able to program in C language with basic programming abilities

5. Course Plan:

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Introduction, pseudocode, data types, single precision floating point, representation, operators, bitwise operators, expressions and statements, operator precedence vs. order of evaluation, type casting, integral promotions, conversions (standard type and arithmetic), if-else condition, for loop, while loop, do-while loop, Jump statements.	
	Unit 2	1-d arrays, Strings, 2-d arrays, structure and union, pointers, functions, header files (math.h, time.h, custom headers), external functions.	
Component 2	Unit 3	Pointers, arrays vs. pointers, Pointers to pointers and pointers to functions, Pre-processor directives and macros, I/O handling.	
	Unit 4	Dynamic memory allocation, Linked lists, Command line arguments, Standard libraries	

6. Text Book:

a. Programming in ANSI C, 7th Edition by E. Balagurusami, TMH

b. Let Us C, 15th Edition by Yashwant Kanetkar, BPB Publication

7. References: a. The C Programming Language, 2nd Edition By Brian W. Kernighan, Dennis M. Ritchie, PHI

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Fundamentals of Electrical and Electronics Engineering

2. LTP structure of the course: 2:1:1

3. Objective of the course: This course is intended to be the text for a first course in electronics engineering. It is partitioned into four parts circuits, electronics, digital systems, and electro-mechanics. Although many topics are covered in each of these parts, the syllabus is more than just a survey of the basics of electrical engineering.

4. Outcome of the course :To provide an overall picture and working principles of electronics and electrical devices.The students will understand the working principles of network theorems, AC circuits, Transformers, Electrical Motors and simple semiconductor diode circuits.

5. Course Plan:

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	**Network Theorems**: Network graphs and matrices, Transient and Steady-State Analysis, theorem.	
	Unit 2	**DC and AC circuits**, Transformer, Transformers, Rotating coil devices	
Component 2	Unit 3	**Semiconductor Diodes**: Semiconductors, Junction diode Zener diodes, Simple circuits	
	Unit 4	**Introduction to Logic Circuits:** Boolean Algebra, Simple gates, Boolean Theorems.	

6. Text Book:

a. Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.

b. Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.

7. References:

a. Network Analysis, M E van Valkenberg, 3rd Edition, PHI, 2000

b. Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches, R A DeCarlo and P-M Lin, 2nd Edition, Oxford University Press, 2000

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: PROFESSIONAL COMMUNICATION

2. LTP structure of the course: 1-0-1

3. Objective of the course: The focus of the course is to engage and involve students with hands on situation and solve problems on regular basis.

4. Outcome of the course: The course is designed to enhance and polish communication skills of undergraduate students which will formally help them to be effective professionals by understanding importance of effective communication, presentation and designing of work.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Types of communication , Speech and diction correction and counseling Formal communication I. Cover letter II. CV preparation III. Group discussion
	Unit 2	IV. Personal interview V. Report writing VI. Proposal development (Product development plan)
Component 2	Unit 3	I. Role play II. Moderation and intervention techniques
	Unit 4	III. SWOT Analysis IV. Interview types and techniques

6. Lab Exercises to be done in LAB Session.

7. References: Winning at Interviews by Edgar Thorpe

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: **Principles of Management**

2. LTP structure of the course: 1-1-0

3. **Objective of the course:**

This course is designed to be an overview of the major functions of management. It explores how organizations develop and maintain competitive advantage within a changing business environment. Upon completion, students should be able to work as contributing members of a team utilizing these functions of management.

4. **Outcome of the course:**

Explain how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment. Practice the process of management's four functions: planning, organizing, leading, and controlling.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Nature and Functions of Management - Importance and Process of Management - Development of Management Thoughts - Managerial Roles
	Unit 2	International Business and its Environment- globalization &WTO-. Dynamics of development Global business environment-. Internal and External analysis. Nature and Importance of Planning Management by Objectives Decision Making MIS Forecasting: Techniques of Forecasting.
Component 2	Unit 3	Need for Organization - Principles and Process of Organizing – Span of Management Organization Structure Departmentalization Authority, Delegation and Decentralization
	Unit 4	Staffing and Directing Requirement of Effective Direction Supervisor and his Qualities Co-Ordination Control

6. Text Book: Mandatory for UG core courses

- Koontz, Weihrich, Aryasri. Principles of Management, TATA McGraw Hill, New Delhi, 2004.

7. References:

- P.C.Tripathi, P.N. Reddy, Principles of Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Prasad LM, Principles and Practice of Management, Sultan Chand & Sons, New Delhi.
- Samuel C. Certo, S. TrevisCerto, Modern management 10 Ed, PHI Learning, New Delhi, 2008
- James A. Stoner, Edward Freeman, Daniel Gilbert, Management, PHI Learning, New Delhi, 2007
- Williams/ Kulshrestha, Principles of Management, Cengage Learning, New Delhi, 2011

SYLLABUS

SEMESTER-2

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus

1. Name of the Course: **Discrete Mathematical Structures**
2. LTP structure of the course: 3-1-0
3. Objective of the course: This is an introductory *course* on *discrete mathematics and structures*. Students will learn: some fundamental mathematical concepts and terminology.
4. Outcome of the course: On completion of this course, students will be able to explain and apply the basic methods of discrete (non-continuous) mathematics in Computer Science. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

5. Course Plan:

Component	Unit	Topics for Coverage
Compoent 1	Unit 1	• **Methods of Proof:** Proof by contradiction, Proof by induction. Usually in such proofs we prove statements of the kind: For all n, n ≥ 0, P(n) holds. Such a proof has two steps, proving the base of induction, and then proving the induction hypothesis, structural induction. This is applicable for entities or structures which are defined inductively, Proof by proving the contrapositive. **Logic & Proofs:** Introduction to Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. Infinite sets, well-ordering. Countable and Uncountable sets, Cantors diagonalization. Mathematical Induction - weak and strong induction.
	Unit 2	• **Sets and Sequences: Data Models:** Finite Sets, Power Set, Cardinality of finite sets, Cartesian Product, Properties of Sets, Vector Implementations of Sets.
Component 2	Unit 3	• **Counting & Combinatorics:** Counting, Sum and product rule, Principle of Inclusion Exclusion. Pigeon Hole Principle, Counting by Bijections. Double Counting. Linear Recurrence relations - methods of solutions. Generating Functions. Permutations and counting. • **Relations & Graphs:** Relations, Equivalence Relations. Functions, Bijections. Binary relations and Graphs. Trees (Basics). Posets and Lattices, Hasse Diagrams. Boolean Algebra.
	Unit 4	• **Algebraic Structures:**Structured sets with respect to binary operations. Groups, Semigroups, Monoids. Rings, and Fields. Vector Spaces, Basis.

6. Text Book: Discrete Mathematics and its Applications, Kenneth H. Rosen, 7th Edition -Tata McGraw Hill Publishers, 2011.
7. References:

- Mathematics for Computer Science, Eric Lehman; F Thomson Leighton; Albert R Meyer, 2010.
- Logic in Computer Science, Huth and Ryan, Cambridge University Press, 2014.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1**. Name of the Course:**Univariate and Multivariable Calculus

2. **LTP structure of the course:** 3-1-0

3. **Objective of the course:** Develop a solid understanding of infinite sequences and series, understand the concept of limit, continuity and differentiability of functions of single and multivariable, understand partial derivatives, directional derivatives of several variable function, rectangular, cylindrical and spherical coordinates systems, Multiple integrals, vector fields.

4. **Outcome of the course:** To Compute limits and derivatives of functions, Apply the Fundamental Theorem of Calculus, Distinguish between the concepts of sequence and series, and determine limits of sequences and convergence and approximate sums of series, and define, differentiate, and integrate functions represented using power series expansions, including Taylor series, Compute limits and derivatives of functions of two and three variables, solve constraint problems using Lagrange multipliers, Evaluate double and triple integrals for area and volume.

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	The Real Number System, Convergence of a Sequence, Monotone Sequences, Cauchy Criterion, Bolzano-Weierstrass Theorem, Continuity and Limits, Existence of Maxima, Intermediate Value Property, Differentiabilty, Mean Value Theorem, Sufficient Conditions for Local Maximum, Point of Inflection
	Unit 2	Taylor's Theorem, Infinite Series, Convergence Tests, Leibniz's Theorem, Power Series, Taylor Series, Riemann Integration, Fundamental Theorems of Calculus, Riemann Sum, Improper Integrals, Area Between Two Curves, Polar Coordinates, Volume of Solids, Length of a plane curve, Areas of Surfaces of Revolution, Calculus of Vector Valued Functions
Component 2	Unit 3	Functions of Several Variables, Directional Derivatives, Gradient, MVT, Maxima, Minima, Second Derivative Test, Lagrange Multiplier Method,
	Unit 4	Multiple integrals, Line and Surface integrals, Green's Theorem , Stokes' Theorem, The Divergence Theorem

6. **Text Book:** G. B. Thomas, M. D. Weir. J. Hass, and F. Giordano, Thomas' Calculus, Pearson.

7. **References Books:**

1. T. M. Apostol, Calculus, Vol. 1, Wiley.

2. T. M. Apostol, Calculus, Vol. 2, Wiley.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Computer Organization and Architecture

2. LTP structure of the course: 2-1-1

3. Objective of the course: A student should grasp the basic concepts of computer arch itecture and organization, and understand the key skills of constructing cost-effective computer systems. A student should learn how to quantitatively evaluate different designs and organizations, and provide quantitative arguments in evaluating different designs. A student should be able to articulate design issues in the development of processor or other components that satisfy design requirements and objectives. In addition, a student should experience use of design tools to model various alternatives in computer design

4. Outcome of the course:

Understand the merits and pitfalls in computer performance measurements; Understand the design process of a computer and critical elements in each step; Understand memory hierarchy and its impact on computer cost/performance; Understand alternatives in cache design and their impacts on cost/performance Understand the impact of instruction set architecture on cost-performance of computer design; Understand contemporary microprocessor designs and identify various design techniques employed; Use a set of hardware simulators to model a complex processor at the behavioral level; Use tools for modeling various microprocessor design alternatives

1. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basic functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Memory system design: semiconductor memory technologies, memory organization. Data representation: signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic.
	Unit 2	Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study - instruction set of some common CPUs.

Component 2	Unit 3	Performance enhancement techniques : Memory interleaving, concept of hierarchical memory organization, cache memory, mapping functions, replacement algorithms, write policy. Peripheral devices and their characteristics: Input-output subsystems, I/O transfers - program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions.
	Unit 4	CPU control unit design: hardwired and micro-programmed design approaches, Case study - design of a simple CPU Performance enhancement techniques Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards

6. Text Book:

David A. Patterson and John L. Hennessy,, Computer Organization and Design: The Hardware/Software Interface Morgan Kaufmann ARM Edition, 2010.

7. References:

i. Carl Hamachar, Zvonco Vranesic and Safwat Zaky, Computer Organization, McGraw Hill

ii. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education

iii. John P. Hayes , Computer Architecture and Organization, McGraw Hill

iv. Morris Mano , Computer System Architecture, Pearson Education

Course Plan for the Lab Component:

a. Familiarization with assembly language programming – using /simulators such as SPIM and ARM based emulators

b. Synthesis/design of simple data paths and controllers, processor design – using Verilog Hardware description language and FPGA board to synthesize the designs.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Data Structures

2. LTP structure of the course: 2-1-1

3. Objective of the course: To teach the linear and non-linear structures in which data can be stored and their pros and cons. To appreciate the need and working of different ways of storing data. To write algorithms that make use of different data structures.

4. Outcome of the course: The students will learn different structures by which data can be stored, retrieved and modified. This forms the foundations for the course on algorithms and a sound knowledge is used in almost every course and project work prescribed by the institute. The course emphasizes on lab work wherein the students learn not only to make different data structures, but also their application in different synthetic problems.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Stacks, Queues, Linked List
	Unit 2	Recursion, Searching and Sorting
Component 2	Unit 3	Trees, Priority Queue
	Unit 4	Hashing, Graphs

6. Text Book:

1. T. H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein,Introduction to Algorithms 3rd ed., PHI, New Delhi, 2009.

2.Y. Langsam, M. J. Augenstein, A. M. Tenenbaum, Data Structures Using C and C++, PHI, New Delhi, 2001.

7. References:

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Principles of Communication Engineering

2. LTP structure of the course: 2-1-1

3. Objective of the course: To let the 2nd Semester B. Tech. (IT) students exposed to fundamental concepts of signals, systems and the communication engineering.

4. Outcome of the course: The students will learn the working principles of wired digital communication systems.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Study of Signals, the Systems and relevant tools like Fourier Transform, Correlation theory etc.
	Unit 2	Signal Digitization and baseband transmission of digital signals
Component 2	Unit 3	Bandpass transmission of digital signals
	Unit 4	Analysis of communication systems in presence of noise

6. Text Book:

1. A. B. Carlson et. al.' *Communication Systems*, 4th/5th Ed., McGraw Hill 2008/20012

7. References:

1. B. P. Lathi et. al., Modern Digital and Analog Communication Systems 4E, Oxford Publication.

Indian Institute of Information Technology, Allahabad

Department of Management Studies

1. **Name of the Course:**Principle of Economics

2. **LTP structure of the Course:** 2-0-0

3. **Objective of the Course:** This course introduces economic analysis of individual, business, and industry choices in the market economy. Topics include the price mechanism, supply and demand, optimizing economic behavior, costs and revenue, market structures, factor markets, income distribution, market failure, and government intervention. Upon completion, students should be able to identify and evaluate consumer and business alternatives in order to achieve economic objectives efficiently.

4. **Outcome of the Course:**

   a) Understand that economics is about the allocation of scarce resources, that scarcity forceschoice, tradeoffs exist and that every choice has an opportunity cost.
   b) List the determinants of the demand and supply for a good in a competitive market andexplain how that demand and supply together determine equilibrium price.
   c) Understand the role of prices in allocating scarce resources in market economies and explainthe consequences of price controls.
   d) Define an externality and a public good and why explain the presence of externalities andpublic goods make markets inefficient. Analyse various government policies aimed atsolving these inefficiencies.

5. **Course Plan:**

Component	Unit	Lecture
Component 1	Unit 1	Introduction to Economics; Production possibilities Supply and demand analysis; The price system and the mixed economy
	Unit 2	Elasticity; Consumer choice and the theory of demand The profit-maximizing competitive firm and market supply Long-run supply in competitive markets ; Production and cost
Component 2	Unit 3	Types of Markets:Monopoly; Perfect Markets Monopolistic competition and oligopoly Antitrust policy and regulation of markets
	Unit 4	Introduction to macro Economics; Macro-Economic Equilibrium GDP; Unemployment; Inflation

6. **Text Books**

   - Principles of Economics: Gregory Mankiw
   - Economics: Samuelson

SYLLABUS

SEMESTER-3

Indian Institute of Information Technology, Allahabad

1**. Name of the Course:** Probability & Statistics

2. **LTP structure of the course:** 3-1-0

3. **Objective of the course:** This course provides an elementary introduction to probability and statistics with applications. The topics covered in this course are basic concept of probability and statistics, random variables, probability distributions, Bayesian inference, joint probability distributions, random vectors, central limit theorem, confidence intervals.

4. **Outcome of the course:** The topics covered in this course would be very much useful for the B. Tech. to develop basic understanding of the subject. This course would also provide the students the background required to apply the basic concepts of probability and statistics in handling large data, analysing noise in a system and studying stochastic processes.

5. **Course Plan:**

Component	Unit	Topics for Coverage
Component 1	Unit 1	Probability: Axiomatic definition, Properties, Conditional probability, Bayes rule and independence of events, Random Variables, Distribution function.
	Unit 2	Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeDiscrete and Continuous random variables, Expectation, Function of random variable, Moments, Moment generating function, Chebyshev's and Morkov's inequality. Bernoulli, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson, Discrete uniform, Continuous uniform, Exponential, Gamma, Normal.
Component 2	Unit 3	Random vector: Joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation, Functions of random variables.
	Unit 4	Law of Large Numbers: Weak law of large numbers, Levy's Central limit theorem (independently and identically distributed with finite variance case), Normal and Poisson approximations to Binomial, Statistics: Introduction: Population, Sample, Parameters, Point Estimation: Method of moments, Maximum likelihood estimation, Unbiasedness, Consistency, Interval Estimation: Confidence interval.

6. **Text Book:**

1. Sheldon M. Ross, An Introduction to Probability Models, 10th Edition, Academic Press, Elsevier.
2. Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.

7. **References Books:**

1. Rohatgi, V. K. and Saleh, A. K. (2000), *An Introduction to Probability and Statistics*, 2nd Edition, Wiley-interscience.

2.Bertsekas, D. P. and Tsitsiklis, J. N. (2008), *Introduction to Probability*, Athena Scientific, Massachusetts.

3. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2012), *An Introduction to Linear Regression Analysis*, 5th Edition, Wiley.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: **Theory of computation**

2. LTP structure of the course: 2-1-1

3. Objective of the course: This course is about the machine construction logic. It is core computer science paper and good for system level engineers.

4. Outcome of the course: Students will get exposure of machine creation mechanism, language construction etc.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	*Regular languages*
	Unit 2	*Context free languages*
Component 2	Unit 3	*Pushdown automata (PDAs)*
	Unit 4	*Turing machines*

6. Text Book: Mandatory for UG core courses

a) Introduction to Automata Theory, Languages, and Computation by John E. Hopcroft , Rajeev Motwani , Jeffrey D. Ullman

7. References:

a) Introduction to the theory of Computation by Michael Sipser,

b) An Introduction to Formal Languages and Automata by Peter Linz

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Object Oriented Methodologies

2. LTP structure of the course: 2-1-1

3. Objective of the course:

- To learn the concept of Object Orientation and its applicability in modelling real life scenarios.
- To get acquainted with UML Diagrams using software tool STARUML.
- To understand Object Oriented Analysis Processes,and Object oriented concepts like data abstraction,encapsulation,inheritance etc.
- To solve the real world problems using top down approach, and understand various Java programming constructs.

4. Outcome of the course:

- Understand Object Oriented Software Development Process; Gain exposure to Object Oriented Methodologies & UML Diagrams; To apply Object Orientation and related advances for software projects.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Characteristic differences between Procedural and Object Oriented approach for programming, Concepts of Class, Objects and Object Oriented Characteristics. Building upon basic programming skills in OO, specifically using basic Java programming constructs for object oriented problem solving (e.g., Classes: Abstraction, inheritance, interfaces, polymorphism), Methods in OO Programming: Method overloading and overriding.
	Unit 2	Design and analysis of larger, more complex programs using Object Oriented Modeling with UML. Why build models of software, Why should we build comprehensive designs before coding Static and Dynamic modeling diagrams and role of Use Case Diagrams.
Component 2	Unit 3	To appreciate the role of Object orientation in problem solving and to be able to design and implement a Java program to model a real world system, and subsequently analyze its behavior. Java implementation for GUI, Event handling and Applets for Web enabled applications. Developing Applications with GUI and Database connectivity.

	Unit 4	Overview of UML for Java Programmers: Class Diagrams Object Diagrams. Sequence Diagrams, Collaboration Diagrams, Static Diagrams: Working with Diagrams and role of Modeling, Making Effective use of UML, Communicating with Others, Back end documentation What to keep, and What to throw away, Iterative Refinement Behavior, Iterative Refinement Minimalism, When to draw diagrams, and when to stop.

6. Text Book:

[1] H. Schildt, Java 2 : A Complete Reference 4th ed, McGraw-Hill, 2001

[2] G. Booch, Object-Oriented Analysis and Design with Applications 2nd Edition, PHI, New Delhi, 1993

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. **Name of the Course :** Operating System

2. **L-T-P structure of the course:** 2-1-1

3. **Objective of the course:**

i. To understand the services provided by and the design of an operating system.

ii. To understand the structure and organization of the file system.

Iii. To understand what a process is and how processes are synchronized and scheduled.

iv. To understand different approaches to memory management.

v. Students should be able to use system calls for managing processes, memory and the file system.

Students should understand the data structures and algorithms used to implement an OS.

4. Outcome of the course:

I. Students should demonstrate the ability to design, implement and evaluate a computer based system, process, program to meet the desired needs
ii. students should demonstrate the ability to apply design and development principles in the construction of software systems of varying complexity
iii. Demonstrate knowledge of system calls, process and thread management, process and thread synchronization, compare and contrast semaphore and mutex, paging and segmented memory
iv. Students should be able to demonstrate the knowledge of file systems and use the knowledge in designing of simple file systems.
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	OS Basics : Definition, Operating Systems as resource manager, Evolution of OS, Structural overview,Types of OS; System Calls, Types of System Call, Hardware requirements: protection, context switching, privileged mode; Processes, Process Concept, Process Scheduling, Threads : Overview, Multithreading Models, Threads and their Management; CPU Scheduling : Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling

	Unit 2	Process Management : Operations on Processes, Interprocess Communication; Process Synchronization : The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Monitors, Semaphores, Classic Problems of Synchronization Deadlocks : System Model, Dynamic Resource Allocation, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery From Deadlock
Component 2	Unit 3	Memory Management: Main Memory Basics, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Basics of Virtual Memory, Demand Paging, Page Replacement, Allocation of Frames, Thrashing Storage Management : Design of IO systems, File Management, Memory Management: paging, virtual memory management, Distributed and Multiprocessor Systems, Case Studies,
	Unit 4	Directory Structure, File-System Mounting, File Sharing, File-System Structure File-System Implementation, Directory Implementation, Allocation Methods, Mass-Storage Structure, Overview of Mass-Storage, Disk Scheduling, Disk Management Case Study – xv6 operating system

6. Text Book:

Abraham Silberschatz Peter B. Galvin and Greg Gagne, Operating System Concepts, Wiley 8th Edition, 2008.

7. References:

i. Garry. J. Nutt, Operating Systems: A Modern Perspective, Addison-Wesley

ii. Andrew S. Tanenbaum and Herbert Bros, Modern Operating Systems (4th Edition), Pearson

ii. William Stallings , Operating Systems: Internals and Design Principles, Prentice Hall of India

iv. D. M. Dhamdhere , Operating Systems: A Concept-Based Approach, Tata McGraw-Hill

v. Russ Cox, Frans Kaashoek, Robert Morris , xv6: a simple, Unix-like teaching operating system

Course Plan for the Lab Component:

a. Introduction to operating systems concepts, process management, memory management, file systems, virtualization, and distributed operating systems. The laboratory exercises will include familiarization with UNIX system calls for process management and inter-process communication; Experiments on process scheduling and other operating system tasks through simulation/implementation.

b. The students would require to apply the operating system concepts by experimenting on either xv6 operating systems.

Indian Institute of Information Technology, Allahabad

Department of Management Studies

1. **Name of the Course:** Introduction to Finance

2. **LTP structure of the Course:** 2-0-0

3. **Objective of the Course:** This course is a rigorous introduction to the study of the basic principles of finance and their application to the usual financial issues and decision-making of business enterprises. The main objective of this course is for the student to obtain at least a good working-knowledge of the topics stated in the tentative course outline below for use in future courses and for careers.

4. **Outcome of the Course:**

   - Identify the objective of the firm and the role of managerial finance.
   - Outline the implications of the separation of ownership and control.
   - Evaluate financial statements using ratio analysis.
   - Explain the general concept of valuing financial assets.
   - Explain the characteristics of debt and equity securities.
   - Identify why firms need to invest in working capital
   - Outline the alternative sources of long-terms fund

5. **Course Plan:**

Component	Unit	Lecture
Component 1	Unit 1	Introduction to financial management;Financial statements basics Ratio analysis
	Unit 2	Time value of money; Capital Budgeting; Relationship between risk and return.
Component 2	Unit 3	Long-term financing decisions; Working Capital Management; Dividend Decision
	Unit 4	Introduction to financial system; Capital Markets; Introduction to International finance and risk management

6. **Text Books**

   - Ross, Westerfield, Jordan, *Essentials of Corporate Finance*
   - James C. Van Horne and John M Wachowicz, *Fundamentals of financial management*
   - Jonathan Berk, *Financial Management*

Indian Institute of Information Technology, Allahabad

Department of Management Studies

Course Syllabus: Introduction to Marketing

1. Name of the Course: **Introduction to Marketing**

2. LTP structure of the course: 1-0-1

3. Objective of the course: To teach the basics of Marketing Management to students from Different streams.

4. Outcome of the course: Make the students excel in Practical world of Business Environment.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Marketing, Marketing Environment.
	Unit 2	Market Segmentation, Market Targeting- Introduction, Procedure.
Component 2	Unit 3	Product Positioning, Consumer Behavior Marketing Mix Decisions, New Product Development. Branding & Packaging Decisions, Product Life cycles. Pricing Decisions, Management of Channels, Retail Distribution system in India.
	Unit 4	Promotion Mix, Marketing of Services, Rural Marketing, CRM, Electronic Marketing, International Marketing.

6. Text Book:

- Kotler Philip, Keller Kevin Lane, Koshy Abraham & JHA Mithileshwar- - Marketing Management: A south Asian Perspective (Pear sons Education 12th Edition).

7. References:

- Kotler Philip- Marketing Management, Analysis, Planning, Implementations & Control (Pear sons Education 12th Edition).
- Stanton William J- Fundamentals of Marketing (MC Graw Hill)
- Kotler, Philip and Armstrong Graw- Principles of Marketing (Pearson Education, 11th Edition)
- Kurtz & Boone Principles of Marketing (Thomas India Edition, 2007)

SYLLABUS

SEMESTER-4

Indian Institute of Information Technology, Allahabad

Department of Information Technology

a. Name of the Course: Design and Analysis of Algorithms

b. LTP structure of the course: 2-1-1

c. Objective of the course: To introduce the student with basic components of algorithm design and to expose them to different ways of analysing an algorithm.

d. Outcome of the course: The students should be conversant with different basic types of algorithms and how to recognise whether a given problem can be solved by one of those types or not. They should also be able to analyse a given algorithms and find out its complexity. The student should also have an understanding of the basic complexity classes.

e. Course Plan:

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Basic Concepts, Definition and Computation of time complexity in asymptotic notations, Heaps, Sorting, Searching, Selection, Hashing	1,2,3,4,6,7,8,9,11
	Unit 2	Greedy Algorithms - Definition, Designing, Analysis, Proof of Correctness; Dynamic Programming - Definition, Designing, Analysis, Proof of Correctness;	15,16,23,24,25
Component 2	Unit 3	Divide and Conquer - Definition, Designing, Analysis; BackTracking Algorithms - Definition, Designing, Analysis; String Algorithms - KMP algorithm, Analysis, Proof of Correctness	32
	Unit 4	Graph Algorithms, Complexity classes - P,NP,definitions, NP-hardness and Completeness, Reduction	22,34

f. Text Book: Introduction to Algorithms (MIT Press) by T H Cormen, C E Leiserson, R L Rivest, and C Stein

g. References:

h. Algorithm Design (Pearson) by J Kleinberg, and E Tardos

i. The Design and Analysis of Algorithms (Pearson) by A V Aho, J E Hopcroft, and J D Ullman

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Principles of Programming Languages

2. LTP structure of the course: 2-1-1

3. Objective of the course:

This course describes the fundamental concepts of programming languages by discussing the design issues of the various language constructs, examining the design choices for these constructs in some of the most common languages, and critically comparing design alternatives.

4. Outcome of the course:

The students are exposed to various constructs of programming languages, their design choices and implementation details. The course increases students capacity to express ideas, improve their background for choosing appropriate programming language, increases ability to learn new languages, provides better understanding of the significance of implementation, and better use of languages that are already known.

5. Course Plan:

Component	Unit	Topics for Coverage	Chapter No.(Optional)
Component 1	Unit 1	Rationale for studying programming languages, criteria used for evaluating programming languages and language constructs, context free grammar, BNF, attribute grammars, semantics: operational, denotational, and axiomatic semantics, various phases of compilers. Design issues for: variables, data types.	1,3,5,6
	Unit 2	Design issues for expressions and assignment statements, control statements, subprograms and their implementation.	7, 8,9,10
Component 2	Unit 3	Data abstraction in-depth discussion of language features that support object-oriented programming (inheritance and dynamic method binding), and exception handling along with a brief discussion of event handling.	11,12,14
	Unit 4	Concurrency, programming paradigms: functional programming with Scheme, brief introductions to ML, Haskell, and F#. introduction to logic programming using Prolog.	13,15,16

6. Text Book: Robert W. Sebesta, Concepts of Programming Languages, Tenth Edition. Pearson.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Computer Networks
2. LTP structure of the course: L:2 T:1 P:1
3. Objective of the course: This course introduces the fundamental concepts of computer networks and different protocols used to connect and transfer data.
4. Outcome of the course: After completing the course, students can realize the network communication, practical experience of networking and usage of specific protocols in various requirements.
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to Computer Networks, OSI & TCP/IP Reference Models, Physical Layer.
	Unit 2	Data Link Layer Framing, Error Control, Error Detection and Correction, Flow Control. Data Link Protocols: Simplex Stop-and-Wait Protocol, Sliding Window Protocols, One-Bit Sliding Window Protocol, Go-Back-N and Selective Repeat, HDLC, PPP Medium Access Control Sublayer, The Channel Allocation. Multiple Access Protocols: ALOHA, Carrier Sense Multiple Access Protocols, IEEE 802.x Ethernet, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, 10 Gigabit Ethernet, Wireless LANs - IEEE 802.xx , Bluetooth, RFID, Bridges, Virtual LANs
Component 2	Unit 3	Network Layer: Design Issues, Store-and-Forward Packet Switching, Virtual-Circuit and Datagram Networks, Routing: Shortest Path Algorithms, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast Routing, Multicast Routing, Anycast Routing, Routing for Mobile Hosts, Routing in Ad Hoc Networks, Congestion Control: Approaches, Traffic-Aware Routing, admission Control, Traffic Throttling, load Shedding. Quality Of Service: Application Requirements, Traffic Shaping, Packet Scheduling, Admission Control, Integrated Services, Differentiated Services, The IPv4 and v6, IP Addressing, Internet Control Protocols, Label Switching and MPLS, OSPF, BGP, Internet Multicasting, Mobile IP.
	Unit 4	Transport Layer: Connection Establishment, Connection Release, Flow Control and Buffering, Multiplexing, Congestion Control Algorithms UDP, Remote Procedure Call, TCP, Delay Tolerant Networks. Application Layer Protocols.

6. Text Book
   - Computer Networks, A System Approach, by Larry L. Peterson ,5 ,Davie .Bruce S th Edition, 2011

7. Reference Books
   - Computer Networks, Andrew S. Tanenbaum, 5th Edition, 2010
   - Routing in Internet, Christian Huitema, 2nd Edition, 1999
   - Internetworking with TCP/IP, Vol. I, Vol. II and Vol. III, by Douglas E. Comer ,3 , Stevens .David L rd Edition, 2000
   - Computer Networking: A Top-Down Approach Featuring the Internet , James F. Kuross, Keith W. Ross., 6th Edition
   - Data Communications and Networking, Behrouz A. Forouzan, 5th Edition, McGraw-Hill.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus

1. Name of the Course: Software Engineering
2. LTP structure of the course: 2-1-1
3. Objective of the course:

- Apply software engineering theory, principles, tools and processes, as well as the theory and principles of computer science and mathematics, to the development and maintenance of complex, scalable software systems. Design and experiment with software prototypes .Select and use software metrics. Elicit, analyze and specify software requirements through a productive working relationship with project stakeholders
- Apply a systematic, disciplined, quantifiable approach to the cost-effective development, operation and maintenance of software systems to the satisfaction of their beneficiaries.
- Build solutions using different technologies, architectures and life-cycle approaches in the context of different organizational structures

4. Outcome of the course:

- Ability to understand software lifecycle development models.
- Ability to understand and apply software requirements engineering techniques.
- Ability to understand and apply software design principles and modeling.
- Ability to understand and apply software testing techniques.Ability to understand the use of metrics in software engineering.Ability to understand formal methods in software development. Ability to establish and participate in an ethical software development team.
- Ability to understand software project management and CASE tools for software development

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction and overview of SE, Software Development Life Cycle
	Unit 2	Requirement, Design and Coding Phase, Testing, verification and validation
Component 2	Unit 3	Client server software development, Software project planning
	Unit 4	Software reliability and quality, Software maintenance and reuse

6. Text Book:

1. Software Engineering, Ian Sommerville, Pearson Education, Inc., publishing as Addison-Wesley.
2. Software Engineering-A practitioner's approach, Roger S Pressman, Mcgraw-Hill

Reference Book:

1. Software Engineering: Principles And Practice, Waman S Jawadekar, Tata McGraw-Hill Education Pvt. Ltd.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: **Database Management System**

2. LTP structure of the course: **2-1-1**

3. Objective of the course: The main objective of this course is to provide students with the background to design, implement, and use database management systems. Database technology though being core subject of all CSE/IT Bachelor programs and assumes special significance due to the highly competitive environment and the explosive use of the internet in Business-to-Client and Business-to-Business applications and the need to store more business data. Recent developments in technologiesis proposed to beincluded.

4. Outcome of the course: Students can apply knowledge of database techniques and appropriate to the discipline. Students can analyze a problem, develop Relational models and identify and define the information needs and requirements appropriate to its' business context and solution. Students can use current relational database techniques, skills, and tools necessary for developing information systems. An ability to use and apply current technical concepts and practices in the relational database management, students should develop the ability to explore recent advances like NoSQL and Linked data principles etc. along with the applications towards data warehousing and data mining. The capability to project mode problem solving needs to be incorporated.

5. Course Plan:

Component	Unit	Topics for Coverage	Chapter No
Component 1	Unit 1	Evolution of Data Centric Systems, Need & Purpose of Database Systems. Database User categories and Database Architecture,	Korth sixth edition Chapter 1
	Unit 2	Data Modeling-ER Diagrams, Case Study discussions for ER Diagrams.	Chapter- 7
		Relational Database-concepts of Keys: Super Key, Primary, Candidate and Foreign Keys. Weak Entity Surrogate Keys.	Chapter-2
Component 2	Unit 3	Integrity constraints, Referential constraints and SQL Constructs. Database languages-Relational Algebra, SQL,PL-SQL.Triggers Embedded SQL and Application Programming Interfaces. Database connectivity-ODBC	Chapter -6
	Unit 4	Relational Database Design issues and Normalization.Functional Dependencies and Various Normal Form Tests.	Korth &.Fundamentals of Database Mangement System–Elmasri Navathe

6. Text Book:

1. Database System Concepts by AviSilberschatz,Henry F. Korth,SSudarshan.
2. Fundamental of Database Systems- Elmasari, Navathe

7. References:

1. Introduction to Database Systems- B.C. Desai
2. Database Management Systems by Jerry Post
3. Ramakrishnan, Gehrke, Database Management System

SYLLABUS

SEMESTER-5

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Graphics and Visual Computing
2. LTP structure of the course: 2-1-1
3. Objective of the course:
4. Outcome of the course:
5. Course Plan:

	Unit	Topics for Coverage
Component 1	Unit 1	Introduction: Basics, applications and scope, Graphics standards, Interaction (sample- and event-driven) and Graphics user Interface (GUI) features. Display Systems: Raster refresh displays, CRT basics, video basics, Flat panel displays. Graphics pipeline, Points and Lines, Line-Drawing Algorithms, Frame Buffer, Circle-Generating Algorithms, Ellipse-Generating Algorithms. Fill Algorithm, Line Attributes, Line Type, Line Width, Digital signal processing, Sampling, aliasing and Antialiasing, Super-sampling Straight Line Segments, Pixel-Weighting Masks, Area Sampling Straight Line, Segments, Filtering Techniques, Pixel Phasing, Compensating for Line intensity Differences, Antialiasing Area Boundaries. Clipping algorithms: line and polygon.
	Unit 2	Transformations: Affine (2-D and 3-D): Rotation, Translation, Scale, Reflection and Shear; Viewing: The Camera Transformations - perspective, orthographic, isometric and stereographic views, Viewing pipeline; Camera Models and multi-view generation. Solid Modeling: Wire-frame, Octrees, Sweep, Boundary representations. Regularized Boolean set operations, Constructive Solid Geometry (CSG); Hierarchical Scene and Object graphs, Scene Description. Hidden Surface Removal: Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area sub-division method, Ray tracing.
Component 2	Unit 3	Hidden Surface Removal: Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area sub-division method, Ray tracing. Shading & Illumination: Light Sources, Basic Illumination Reflection Models, Ambient Light, Diffuse Reflection (Lambert's cosine law), Specular Reflection and the Phong Model. Combined Diffuse and Specular Reflections with Multiple Light Sources, Intensity Attenuation, Color Considerations, Transparency, Shadows, Texture mapping, Polygon-Rendering Methods

	Unit 4	Curves and Surface: Interpolation and Approximation Splines, Continuity, Natural Cubic Splines , Hermite Interpolation, Cardinal Splines, Kochanek-Bartels Splines, Bezier Curves and Surfaces, Bezier Curves, Matrix Representation, Conversion Between Spline Representations. Fractals: Fractal Dimension and Geometry, Generation and Classification of Fractals, Self-Similar Fractals, Affine Fractal-Construction Methods. Applications. Introduction to GPUs.

6. Text Book: Donald Hearn & M. Pauline Baker, *Computer Graphics.*

7. Reference:

1. Foley, van Dam, Feiner & Hughes, *Computer Graphics Principles & Practice*

2. MIT Open Courseware: *http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-837-computer-graphics-fall-2012/*

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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:

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: **Artificial Intelligence**
2. LTP structure of the course: 2-1-1

3. Objective of the course: This course introduces students to the basic knowledge representation, problem solving, and learning methods of artificial intelligence.

4. Outcome of the course: On completion of this course, students would be able to develop intelligent systems by assembling solutions to concrete computational problems; understand the role of knowledge representation, problem solving, and learning in intelligent-system engineering; and appreciate the role of problem solving in understanding human intelligence from a computational perspective.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction to AI in Problem Solving Intelligent Agents Searching
	Unit 2	Informed Search Constraints Satisfaction Problems Adversarial Search
Component 2	Unit 3	Planning Uncertainty
	Unit 4	Making Simple and Complex Decisions Reinforcement Learning

6. Text Book: Artificial Intelligence: A Modern Approach, S. Russell, P. Norvig; 3rd edition, Pearson, Essex, England, 2016.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: **MINI Project**

2. LTP structure of the course: 0-1-3

3. Objective of the course: This Course aims to Introduce the application of the knowledge going by the different courses in form of a Project.

4. Outcome of the course:Preferably adding the knowledge/ application to the society.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Identification/ Background Literature
	Unit 2	Literature Survey, Research Gap and Proposed Methodology
Component 2	Unit 3	Project
	Unit 4	Demonstration

SYLLABUS

SEMESTER-6

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: Data mining

2. LTP structure of the course: 2-1-1

3. Objective of the course: Talks about mining issues and methods/algorithms.

4. Outcome of the course: Students will get exposure of data mining algorithms and its implementations.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Introduction: Fundamentals of data mining, Functionalities, issues. Association mining
	Unit 2	Classification
Component 2	Unit 3	Classification continue, Clustering
	Unit 4	Clustering continue

6. Text Book:

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

7. References:

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

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus:

1. Name of the Course: MINI PROJECT-2
2. L-T-P: 0-1-5

3. Objective of the course: This Course aims to Introduce the application of the knowledge going by the different courses in form of a Project.

4. Outcome of the course: Preferably adding the knowledge/ application to the society.

SYLLABUS

SEMESTER-7

Indian Institute of Information Technology, Allahabad

Department of Information Technology

1. Name of the Course: MINI PROJECT-3
2. L-T-P: 0-1-7

3. 3. Objective of the course: This Course aims to Introduce the application of the knowledge going by the different courses in form of a Project.
4. 4. Outcome of the course: Preferably adding the knowledge/ application to the society.

SYLLABUS

SEMESTER-8

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus:

1. Name of the Course: PROJECT
2. L-T-P: 0-2-10

3. Objective of the course: This Course aims to Introduce the application of the knowledge going by the different courses in form of a Project.

4. Outcome of the course: Preferably adding the knowledge/ application to the society.

ELECTIVE LISTS

MACHINE LEARNING BASKET

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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: Subgradient 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

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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**. T**his 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:**

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Syllabus

Name of the Course: **Information Retrieval**

1. 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.

2. 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.

3. Course Plan:

		Topics for Coverage
Component 1	**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
	Unit 2	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
		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

Component 2	**Unit 3**	Query Expansion Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query drift Probabilistic 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.

Books:Introduction to Information Retrieval by Christopher D. Manning

Natural Language Processing And Information Retrieval by *Tanveer Siddiqui and U. S. Tiwary*

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Course Syllabus

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 and Clustering : Revision. Data Streams mining, Social Network Analysis, Graph mining
	Unit 2	Mining algorithms for large data, Mining Big Data, Hadoop, Map-Reduce, HDFS, Spark + seminars
Component 2	Unit 3	Mining Sequence pattern in TD, Mining Time-series data, , Mining WWW + seminars
	Unit 4	Advanced Machine Learning: Deep Learning, 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”

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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 Extraction Machine 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.

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Department of Information Technology

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 Goodfellow, Yoshua Bengio and Aaron Courville

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

IMAGE & VISUAL ANALYTICS- BASKET

Indian Institute of Information Technology, Allahabad

Information Technology

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 PerceptionandProcessing,neuromorphiccomputing.

	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 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.

5. 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

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Department of Information Technology

Syllabus

1. Name of the Course: Visual Recognition

2. LTP structure of the course: 2-1-1

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:

	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, ; Convolutional Networks with Variable-sized Inputs, Intro to YOLO - Single Shot Object Detection; Deep Feature Learning methods: Representation learning, Transfer Learning.
	Unit 4	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

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Course Syllabus

1. Name of the Course: **Computational Astrophysics**

2. LTP structure of the course: **2-1-1**

3. Objective of the course: *Expose the students of B.Tech. /M.Tech. to Astronomical Observation in multi-wave lengths and the large data archives available for analysis through Machine Learning tools.*

4. Outcome of the course: *Students will learn different signal processing techniques to acquire and calibrate data. Use and handle large data base on the cloud and Apply Machine Learning Techniques to extract information from data and using information to build knowledge which will eventually lead to scientific discovery.*

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	***Astronomy, Astronomical Observation: Telescopes at different wavelengths (Gamma Rays to Radio), Astronomical Instruments. Methods of observation.***
	Unit 2	***Data and databases: Virtual Observatory, Data Representation: Data formats, (Flexible Image Transport System (FITS). N-dimensional Data Format (NDF), Hierarchical Data System (HDS)).***
Component 2	Unit 3	***Methods of data reduction: Data Calibration: Systematic errors, Photon Noise, Detector aberrations (Dark, bias, Flat, Fringe Effect due to thinned detector). Fourier transforms, Multi aperture Imaging, Self Calibration. Visualization: Plotting 1D, 2D, 3D, Multi-D, Animation.***
	Unit 4	***Errors and error propagation, interpolation, random numbers, Astro-statistics, probability distributions, hypothesis testing, sampling methods, multivariate analysis, regression, time-series analysis, data reduction and Astronomical Machine Learning (AstroML).***

6. Text Book:

- Eljko Ivezic, Andrew Connolly, Jacob Vanderplas, Alexander Gray, Andrew J. Connolly, Jacob T Vanderplas;**Statistics, Data Mining, and Machine Learning in Astronomy – A Practical Python Guide for the Analysis of Survey Data** *(Princeton Series in Modern Observational Astronomy)* **18 Feb 2014**
- **C.R. Kitchin;**Astrophysical Techniques, **Sixth Edition ; CRC Press; 6 edition (19 December 2013)**

7. References:

1. Eljko Ivezic, Andrew Connolly, Jacob Vanderplas, Alexander Gray, Andrew J. Connolly, Jacob T Vanderplas;**Statistics, Data Mining, and Machine Learning in Astronomy – A Practical Python Guide for the Analysis of Survey Data** *(Princeton Series in Modern Observational Astronomy)* **18 Feb 2014**
   ISBN-10: 0691151687 **ISBN-13:** 978-0691151687
2. Michael J. Way, Jeffrey D. Scargle, Kamal M. Ali and Ashok N. Srivastava **, Advances in Machine Learning and Data Mining for Astronomy;** *Chapman and Hall/CRC; 1 edition* (16 November 2016)
   ISBN-10: 1138199303 **ISBN-13:** 978-1138199309
3. C.R. Kitchin;**Astrophysical Techniques,** Sixth Edition ; CRC Press; 6 edition (19 December 2013)
4. **Bevington, Data Reduction and Error Analysis for Physical Sciences,** 3Ed. McGraw-Hill, **2015.**
   ISBN-10: 9339221206 **ISBN-13:** 978-9339221201
5. **Smith, Robort C., Observational Astrophysics ISBN-10:** 0521278341 **ISBN-13:** 978-0521278348
6. **Press, W.H., et al., Numerical Recipes in C, Cambridge University Press, 1992.**
7. **Babu G. J. & Fiegelson, E. D., Astrostatistics, Chapman and Hall, 1996.**
8. **S.M.Miyama, K.Tomisaka & T Hanawa, Numerical Astrophysics**

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Department of Information Technology

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.

6. Text Book: Introduction to Biometrics, Jain, Anil, Ross, Arun A., Nandakumar, Karthik
7. Reference:

- IEEE Transactions on Information Forensics
- IEEE Transactions on Image Processing
- IET Biometrics
- IET Image Processing

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Department of Information Technology

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

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Department of Information Technology

1. Name of the Course: Data Compression

2. LTP structure of the course: 2-1-1

3. Objective of the course:

   a. To provide the students with the basic data compression methods used for text, audio, image and video data.

   b. To provide the understanding of practicality of basic communication theory into data compression.

   c. To provide the students with an exposure of latest state of the art methods.

4. Outcome of the course:

   d. The students shall be able to apply the knowledge gained during the course to solve various real time data compression problems.

   e. The students shall be able to develop new state of the art data compression methods and algorithms.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Compression techniques: Lossless and Lossy compression, modelling and coding, performance measures, and types of redundancy. Lossless Compression: Information theory and source coding, Physical models, Probability models, Markov models, composite model, Kraft-McMillan Inequality, uniquely decodable codes, prefix

		codes and optimality condition. Huffman codes, minimum variance Huffman codes, extended Huffman codes, non-binary Huffman codes, Adaptive Huffman codes.
	Unit 2	Golomb codes, Rice codes, Tunstall codes and application to lossless image, text and audio compression. Arithmetic coding techniques and variants. Dictionary techniques: Static dictionary and diagram coding, adaptive dictionary: LZ77, LZ78 and LZW. Context based compression: prediction with partial match (ppm), Burrows-wheeler transforms (BWT) and move-to-front encoding, dynamic Markov compression.
Component 2	Unit 3	Lossy compression: Distortion criterion, human visual and auditory differential entropy, rate distortion theory and lossy compression models. Scalar quantization: Uniform, forward and backward adaptive quantization, Jayant-quantizer, non-uniform quantization and entropy-coded quantizer, Lloyd-Max quantizer. Vector quantization: Linde-Buzo-Gray (LBG) algorithm and tree structured vector quantizers. Differential encoding: Basic algorithm, DPCM and ADPCM and delta modulation.
	Unit 4	Introduction to transform and sub-band coding, wavelet based compression, audio and video compression standards.

T
ext Book: Intr
Intoduction to Data Compression, 3rd Edition, by Khalid Sayood, Morgan Kaufmann

Reference: Data Compression: Complete Reference, 4th Edition, by David Soloman, Springer-Verlag

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Department of Information Technology

1. Name of the Course: Document Image Analysis (DIA)
2. LTP structure of the course: 2-1-1
3. Objective of the course: Students will get of an overview of DIA.
4. Outcome of the course: Students will get of an overview of DIA.
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Basics of DIA: Image Processing Methods for Document Image Analysis; Function Approximation and Pattern Classification, Multiple Classifier Decisions for OCR
	Unit 2	Character Recognition: Hand-printed Digit Recognition, Cursive Handwriting Recognition, Word Recognition using HMM, Oriental Character Recognition.
Component 2	Unit 3	Structured and Unstructured Documents Image Analysis, Document Structure Representation, Analysis of Engineering Drawing and printed Characters, Paper based Map Processing and Interpretation, Mathematical and Music Notations,
	Unit 4	Special DIA Systems and Applications: Automated Signature Verification, Bank Cheque Analysis Recognition, Information Retrieval and OCR, Benchmarking of DIA Systems.

8. Text Book: Handbook of Character Recognition and Document Image Analysis by: H Bunke, P S P Wang
9. Reference:
    - IEEE Transactions on Information Forensics
    - IEEE Transactions on Image Processing
    - IET Image Processing

Indian Institute of Information Technology, Allahabad
Department of Information Technology

1. Name of the Course: Remote Sensing and GIS
2. LTP structure of the course: 2-1-1
3. Objective of the course:
    a. The students will learnthe basics of Remote Sensing, Image Acquisition and GIS principles.
    b. The students will learn the applications of Remote Sensing and GIS.
4. Outcome of the course:
    a. The students will be able to understand Remote Sensing and GIS principles
    b. They will be able to work on Remote Sensing and GIS Data for various applications
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Remote Sensing Principles Scope of remote sensing, Remote sensing imagery, Energy sources and radiation principles, Electromagnetic radiation and its interaction with the surfaces and atmosphere, Land observation satellites, Active and Passive Remote sensing.
	Unit 2	Image Acquisition Fundamentals of image acquisition, Digital photographic sensor systems, the role and importance of digital data, Ground truth, Image interpretation, Various Earth observation missions, Microwave, LiDAR, Thermal sensor systems, The role of image resolution in projects integrating remote sensing and GIS.
Component 2	Unit 3	Image Analysis Image preprocessing (i.e. radiometric, geometric corrections, and feature extraction), Pattern recognition, shape analysis, Textural analysis, Digital image classification, Accuracy assessment. Hyperspectral remote sensing.
	Unit 4	GIS and Remote Sensing Applications Information system, Components of GIS, Geospatial data architecture, Geographic co-ordinate systems, Map projections, GIS categories, GIS data types, data Representation, Data sources, GIS software, Land use/land cover analysis, geologic, geomorphic, soil and hydrologic phenomena at a variety of scales.

6. Text Books:
    a. Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote sensing and image interpretation, John Wiley & Sons, 2008
7. References:
    a. George Joseph, Fundamentals of Remote Sensing Universities Press, Hyderabad 2005
    b. Kang tsung Chang, Introduction to Geographical Information System, Tata McGraw Hill, 7th edition, 2010

c. A.M. Chandra and S.K. Ghosh. Remote Sensing and Geographical Information system. Narosa Publishing House, New Delhi, 2006

SOFTWARE ENGINEERING- BASKET

Indian Institute of Information Technology, Allahabad

M.Tech Software Engineering
Course Syllabus

Name of the Course: Software Requirements and Engineering(SRE)

1. LTP structure of the course: 2-0-1

2. Objective of the course:

- Execute a complete requirements negotiation process.
- Perform a comprehensive feasibility analysis.
- Lead a software project planning process, to include determining deliverables; effort, schedule and cost estimation; resource allocation; risk management; quality and plan management.
- Apply the principles and processes of software engineering project enactment
- Perform software project reviews and evaluations according to best practices.
- Employ software engineering measurement processes.
- Utilize software engineering management tools.

3. Outcome of the course:

At the end of the course the student will be able to:
1. Gain Knowledge about software requirements.
2. Analyze requirement elicitation techniques and prototyping.
3. Gain knowledge about requirement management, their principles and practices.
4. Analyze use case modeling and different data diagrams.
5. Estimating the software in terms of size, cost, effort and schedule.

4. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Software Requirements: What and Why?** • Essential Software Requirement • Good practices for requirement engineering • Improving requirements processes • Software Requirements and Risk Management
	Unit 2	**Software Requirements Engineering** • Requirements elicitation • Requirement analysis documentation, review, elicitation

		techniques, analysis models, software quality attributes • Risk reduction through prototyping, setting requirements priorities, verifying requirements quality, software requirements modeling • Use case modelling, Analysis model, dataflow diagrams, state transition diagram, class diagram, object analysis, problem frames
Component 2	Unit 3	**Software Requirements Management** • Requirements management principles and practices • Requirement attributes, change management process • Requirement traceability matrix • Links in requirements chain Requirement management tool,benefits of requirement management tools, commercial requirement management tools • Rational Requisite pro • Caliber-RM, Implementing requirement management automation
	Unit 4	**Software Estimation** • Components of software estimation, software estimation models, Problems associated with estimation, Key project factors that influence estimation • **Size estimation-** two views of sizing, Function point analysis, Mark II FPA, full function point, LOC estimation, conversions between size measures. • What is productivity, estimation factors, approaches to effort and schedule estimation • COCOMO II, Putnam estimation model • Algorithmic models, cost estimation, software estimation tools, desirable features of software estimation tools • IFPUG, USC's COCOMO II, SLIM (Software Lifecycle Management) tools.

5. Text Book:

- Swapna Kishore, Rajesh Naik, Software Requirements and Estimation,1st Edition, Tata Mc Graw Hill, 2001.

6. Reference Book

- Karl E. Weigers, Software Requirements, 2nd Edition, Microsoft Press, 2003.
- Ian K. Bray, An Introduction to Requirements Engineering, Addison Wesley, 2002
- Ian F. Alexander, Richard Stevens, Writing better requirements, Addison-Wesley, 2002

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Course Syllabus

Name of the Course:Software Metrics (IISM140C)

1. LTP structure of the course: 2-1-0

2. Objective of the course:

Understand the theoretical aspects of software measurements.

- Demonstrate the knowledge of software metrics.
- Demonstrate the knowledge of using software metrics in software development, software maintenance, and software project management.
- Demonstrate the knowledge of statistical analysis in software measurement.
- Demonstrate the knowledge of developing and calibrating predication systems.
- Demonstrate the knowledge of developing and maintaining a measurement program.

3. Outcome of the course:

Upon completion of this course, students will have the ability to:

- Understand the basic metrics and measurement theory and terminology.
- Select software metrics based on goals.
- Design and tailor the selected metrics to match your information needs.
- Determine what data to collect and who should collect it.
- Interpret and communicate metric results.

4. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Theoretical foundations for software metrics:** • Introduction to the measurement theory. • The representational theory of measurement. Empirical and numerical systems. • Measurement scales. • Meaningfulness in measurement. • Operations on measures. • Representation condition. • Software measure classification • Goal-based paradigms: Goal-Question-Metrics (GQM) and Goal-Question-Indicator-Metrics (GQIM) • Applications of GQM and GQIM
	Unit 2	**Empirical Investigation:** • Software engineering investigation • Investigation principles • Investigation techniques • Guidelines for empirical research

		• Data collection and analysis • Analyzing software measurement data
Component 2	Unit 3	**Measuring internal software attributes:** • Size – Aspects of software size, length, reuse, functionality, complexity, • Measuring internal software attributes: structure – Types of structural measures, control-flow structure, modularity and information flow attributes,object-oriented metrics, data structure, difficulties with general complexities measures, • Measuring external software attributes – Modeling software quality, measuring aspects of quality. • Resource measurement: productivity, teams and tools – Meaning of productivity,productivity of what? Measuring productivity, Teams, tools and methods, • Making process predictions – Good estimates, cost estimation: problems and approaches, models of effort and cost, problems with existing modeling methods, dealing with problems of current estimation methods, implications for process prediction.
	Unit 4	**Planning a measurement program:** • What is a metrics plan, developing goals, questions, and metrics, mapping measures to activities, measurement tools, measurers, analysts and audience, revising the plan • Measurement in practice – success criteria, measurement in the small and in the large,lessons learned • Empirical research in software engineering – problems with empirical research, Investigating products, resources, processes.

5. Text Book

- Norman E. Fenton and Shari Lawrence Pfleeger; Software Metrics - A Rigorous and Practical Approach, Thomson Asia Pte. Singapore.

6. References Book

- Stephen H. Kan; Metrics and Models in Software Quality Engineering, Addison Wesley, New York.
- K.H. Moller and D.J. Paulish; Software Metrics – A Practitioner's Guide to Improved Product Development, Chapman and Hall, London.
- Mark Lorenz and Jeff Kidd; Object- Oriented Software Metrics, Prentice Hall, New York.

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Course Syllabus

Name of the Course Software Process Management (SPM) (ISPM)

1. LTP structure of the course: 2-2-0

2. Objective of the course:

Understand the fundamental principles of Software Project management & will also have a good knowledge of responsibilities of project manager and how to handle these. n Be familiar with the different methods and techniques used for project management. n By the end of this course student will have good knowledge of the issues and challenges faced while doing the Software project Management and will also be able to understand why majority of the software projects fails and how that failure probability can be reduced effectively. Will be able to do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques

3. Outcome of the course:

Upon completion of the course, students will be able to demonstrate professional level competencies in the following key areas of software project management and project management leadership.

- Manage the selection and initiation of individual projects and of portfolios of projects in the enterprise.
- Conduct project planning activities that accurately forecast project costs, timelines, and quality. Implement processes for successful resource, communication, and risk and change management.
- Demonstrate effective project execution and control techniques that result in successful projects.
- Conduct project closure activities and obtain formal project acceptance.
- Demonstrate a strong working knowledge of ethics and professional responsibility.
- Demonstrate effective organizational leadership and change skills for managing projects, project teams, and stakeholders.

4. Course Plan:

Component	Unit	Topic for coverage
omponent 1	**Unit 1**	**SOFTWARE PROCESS MATURITY** ● A Software Maturity Framework, The Principles of Software Process Change, Software Process Assessment, The Initial Process.
	Unit 2	**THE REPEATABLE PROCESS.** ● Managing Software Organizations, The Project Plan, Software Configuration Management—Part 1: Software Quality Assurance

Component 2	**Unit 3**	**UNIT III: THE DEFINED PROCESS.** ● Software Standards, Software Inspections, Software Testing, Software Configuration Management (Continued),Defining the Software Process, The Software Engineering Process Group
	Unit 4	**UNIT III: THE DEFINED & MANAGED PROCESS.** ● Software Standards, Software Inspections, Software Testing, Software Configuration Management (Continued),Defining the Software Process, The Software Engineering Process Group ● Data Gathering and Analysis, Managing Software Quality

5. Text Book:

- **Managing the Software Process by Watts S. Humphrey**, *Carnegie-Mellon University* ISBN-10: 0201180952 • ISBN-13: 9780201180954, ©1989 • Addison-Wesley Professional

6. Reference Book:

- **Software Project Management in Practice, 1/E, Pankaj Jalote**ISBN-10: 0201737213 • ISBN-13: 9780201737219 ©2002 • Addison-Wesley Professional

Course Syllabus

Name of the Course:Software Testing and Quality Management (ISTQ)

1. **LTP structure of the course: 2-1-1**
2. **Objective of the course:**
   - Develop methods and procedures for software development that can scale up for large systems and that can be used to consistently produce high-quality software at low cost and with a small cycle time
   - Student learn systematic approach to the development, operation, maintenance, and retirement of software
   - Student learn how to use available resources to develop software, reduce cost of software and how to maintain quality of software
   - Methods and tools of testing and maintainace of software's.

3. Outcome of the course:

Upon completion of this course, students will have the ability to:

- Software "V" model of testing
- Static and dynamic testing techniques
- Software testing metrics
- Process management
- Quality software processes
- Risk management
- Configuration management and quality assurance

4. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	• Software Testing: o Introduction, Meaning, What is Bug? Reasons of Bugs, Cost of Bugs, Software Tester Task. • Introduction to Software Development Models o Software Testing: Testing axioms, Terms & Definitions • Testing Fundamentals: o Types, Black Box, White Box, Static & Dynamic Testing. Static Black Box Testing. • Dynamic Black Box Testing: o Test to Pass & Test to Fail, Equivalence Partitioning, Data Testing, State Testing, , Other Black Box Testing Techniques.

	Unit 2	• Static White Box Testing: o Formal Reviews, Peer Reviews, Coding Standards and Guidelines. Review Check List • Dynamic White Box Testing: o Comparison with Debugging, Testing Pieces: Unit & Integration TestingConfiguration Testing: o Overview, Software and Hardware Devices. Deciding Hardware Configurations. • Compatibility Testing: – Overview, Backward and Forward Compatibility. Testing Multiple versions. Data Sharing Compatibility • User Interface Testing: o Effective UI, Testing for Disabled. o Data Coverage & Code Coverage
Component 2	Unit 3	• Documentation Testing: o Types of Documentation, Importance of Documentation Testing. • Security Testing: o Threat Modelling, Buffer Overrun, Safe String Functions, Computer Forensics • Web Site Testing: o Web Page Fundamentals, Black Box Testing: Text, Hyperlinks, graphics, Forms. Gray Box Testing & White Box Testing, Configuration and Compatibility Testing • System Testing o Recovery Testing o Security Testing o Stress Testing o Performance Testing
	Unit 4	• Planning Testing: – Goals, Test phases, Strategy, Resource Requirements, Schedule, Test Cases, Bug Reporting, Metrics.

		• Test Cases: – Test Case Planning, Design, Cases, Procedures, Organization and Tracking. • Bug Life Cycle and Tracking System. • Testing, QA and QC – Quality Management – Quality Planning Process – Quality Assurance Process – Quality Control process • Organisational Structures: – CMM Capability Maturity Model, – ISO 9000.

5. Text Book:

1. Kshirasagar Naik and PriyadarshiTripathy, Software Testing and Quality Assurance: Theory and Practice, John Wiley & Sons, Inc.

6. Reference Book:

1. William Perry, “Effective Methods for Software Testing”, John Wiley & Sons, New York, 1995.
2. Louise Tamres, “Software Testing”, Pearson Education Asia, 2002
3. Robert V. Binder, “Testing Object-Oriented Systems-Models, Patterns and Tools”, Addison Wesley, 1999.
4. CemKaner, Jack Falk, Nguyen Quoc, “Testing Computer Software”, Second Edition, Van Nostrand Reinhold, New York, 1993
5. Boris Beizer, “Black-Box Testing – Techniques for Functional Testing of Software and Systems”, John Wiley & Sons Inc., New York, 1995.

Course Syllabus A Template

1. Name of the Course: Agile Software Development Engineering

2. LTP structure of the course: 4 credit [3-1-0]

3. Objective of the course:

Agile methodology has made the software development industry rethink the traditional approach . Everyone wants to be agile, but what does it really mean and how do you achieve agile development? This computer science course cuts beyond the agile methodology hype and teaches you the fundamental agile concepts that span a wide range of methodologies. It analyzes the key agile ideas, their benefits, their limitations, and how best to take advantage of them to enhance your software skills and show employers that you have mastered an essential component of today's IT industry.

The course is divided into following parts:

1. The Agile manifesto and the context of agile methods
2. Agile principles and values: what key methodological ideas underlie the agile movement?
3. Agile roles and Learning Environments: how does agile redefine traditional software jobs and tasks, in particular the manager's role?
4. Agile practices: what are the concrete techniques that agile teams use to apply these methods?
5. Agile artifacts: what practical tools are essential to the work of agile developers?
6. Agile Quality Assurance: among agile ideas, which ones are essentially hyped and useless, which ones are actually harmful, and which ones will truly help you effectively produce high-quality software?

4**. Outcome of the course:**

- Agile principles, roles, practices, and artifacts
- Describe two or more agile software development methodologies.
- Identify the benefits and pitfalls of transitioning to agile.
- Compare agile software development to traditional software development models.
- Pros and cons of the most popular agile methods
- How to benefit from agile methods and tools in general

5. **Course Plan:**

Component 1	**UNIT -1**	**Introduction of Agile Manifesto and agile software development methods**
		What is Agile Development, Agile Software Engineering Fundamentals, Agile Software Development Methods, The Agile Manifesto, Agile Modeling, Agile Unified Process (AUP), Dynamic Systems Development Method (DSDM), Essential Unified Process (EssUP), Extreme Programming (XP),Feature Driven Development (FDD), Open Unified Process (OpenUP), Scrum, Velocity tracking.
	UNIT -2	**Agile Principles and Values**
		Official Agile Principles, Agile Values, An Agile Project Case Study, Agile vs. Waterfalls, Application of Agile Software Development
	UNIT -3	**Agile Roles and Learning Environments**

		A Role Scheme in Agile Teams, Teamwork in Learning Environments, Customers and Users in Learning Environments, Leadership in Learning Environments, Delivery and Cyclicality in Learning Environments, Time Management of Agile Projects, Extreme programming, The Strengths and Weaknesses of Extreme Programming, Test-driven development, Scaling agile methods, , Globalization in Learning Environments Agile methods for large systems, Application of Agile Principles in Non-Software Projects
Component 2	**UNIT-4**	**Agile practices**
		Test-first programming (or perhaps Test-Driven Development), Rigorous, regular refactoring, Continuous integration, Simple design, Pair programming, Sharing the codebase between all or most programmers.
		Agile Artifacts
		Team management tools, Source control tools, Continuous integration tools.
		Agile Quality Assurance
		The Agile Approach to Quality Assurance, Quality in Learning Environments, Teaching and Learning Principles-The Case of Quality, Abstraction Levels in Agile Software Development, The Agile Approach in Global Software Development, Monitoring a Large-Scale Project.

6. Book **Text:**

[1] Essential Scrum: A Practical Guide to the Most Popular Agile Process, Kenneth S. Rubin, 2012 (ISBN-10: 0137043295, ISBN-13: 007-6092046028)
[2] Manifesto for Agile Software Development, http://www.agilemanifesto.org
[3] Agile Software 2009th Edition, by Orit Hazzan,. Yael Dubinsky
[4]Software Engineering 10th Edition, by Ian Sommerville's

Reference Books/Links

[1] https://techbeacon.com/top-agile-tools-keep-software-engineers-productive

[2] https://en.wikibooks.org/wiki/Introduction_to_Software_Engineering/Process/Agile_Model

1. Name of the Course: Software Design and Architecture

2. LTP structure of the course: [3-0-0]

3. Objective of the course:

The main objective of this course is to provide students with the background to design, implement, and use mid size and large software systems. The software design aspects with special focus on Object Oriented Design can be started with Design objectives and will continue with OO Design Principles. The Design Patterns with GoF dictum to be discussed. The 23 classic Design Patterns may be explored to complete the Design Aspects whereas the Architectural consideration to be covered in next part of the Course. In the Architectural discussions the issues emanating from the concept of "Separation of Concerns" with different Architectural realizations has to be understood. The increasing role of Cloud services and how it affects the Architectural decisions is also proposed to be handled through Case Studies discussions.

The course though being core subject of all CSE/IT Master programs (Software Engineering specializations) and assumes special significance due to the highly competitive environment and the explosive use of the Internet and Cloud Services in Business-to-Client and Business-to-Business applications and thus need to be explored accordingly. Recent developments in technologiesis proposed to beincluded.

4**. Outcome of the course:**

- To understand the objectives of Software Architectural design.
- To learn various Software Architecture prevalent wrt MVC , SOA etc.

Students can apply knowledge of Software Design techniques and apply appropriate architectural considerations to the projects. Students can analyze a problem, develop models and identify and define the functional and non-functional needs and requirements appropriate to its' business context and solution. Students can use current techniques, skills, and tools necessary for developing software systems. An ability to use and apply current technical concepts and practices, students should develop the ability to explore recent advances. The capability to project mode problem solving needs to be incorporated.

5. **Course Plan:**

Component 1	**UNIT -1**	**Introduction to Algorithm Design, Software Design and Architecture**
		What is Software system Design objectives, purpose and approaches of efficient system design, Functional Independence in Software Design with Coupling and Cohesion. Overview of OO Design: Class Diagrams Object Diagrams. Sequence and Collaboration Diagrams, Static and dynamic modeling approaches for efficient design
	UNIT -2	**Software Design Principles**
		Role of Modeling and Design, Design Metrics, OO Software Design. Design Principles with applications. . Iterative Refinement Behavior, Iterative Refinement Minimalism. Mobile Software and Design: Characteristics and Requirements, Mobile Interaction designs, UX design.
	UNIT -3	**Design Patterns and Architectural consideration**
		Recent Trends in Software Design with special focus on Mobile Apps Development. The GoF and evolution of Design Patterns
Component 2	**UNIT-4**	**Pattern based Design**
		Design Patterns with Creational Design Patterns, Structural Design

		Patterns and Behavioral Design Patterns. Example elaborations of popular patterns with suggested areas of Applications.
		Architecture Types and Representation
		Role of Software Architecture, Module View, Data Flow View, Layers View. Technical Architecture, Business Architecture, Solutions Architecture & Enterprise Architecture. Architecture for Web enabled applications. Separation of Concerns, Developing Application Architecture with GUI and Database connectivity. Database Design and Data Centric Architectures
		Architectural Implementations
		MVC Architecture and Separation of Concerns, SOA and Web Services, RESTFul services and API. Advances in Software Architecture. Recent Trends in Software Architecture: Cloud Based Architecture, Service Oriented Architecture etc..

6. **TEXT BOOKS:**

[1] G. Booch, Object-Oriented Analysis and Design with Applications 2nd Edition, PHI, New Delhi, 1993.
[2] Design Patterns by Ralph Johnson, John Vlissides, Richard Helm, and Erich Gamma.
[3] Software Architecture: Foundations, Theory, and Practice by Richard N. Taylor et al.(John Wiley and Sons).

REFERENCES:

1. Frank Buschmann, Kelvin Henney & Douglas Schimdt, “Pattern-Oriented Software Architecture - A System of Patterns”, Volume 1, Wiley,2007.

2. Frank Buschmann, Kelvin Henney & Douglas Schimdt, “Pattern-Oriented Software Architecture – Pattern for Concurrent and Networked Objects”, Volume 2 ,Wiley, 2000.

3. Mary Shaw , David Garlan , “Software architecture perspectives on a Emerging Dicipline”,EEE,PH1,1996.

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Course Syllabus A Template

1. Name of the Course: Software Quality Management

2. LTP structure of the course: [3-1-0]

3. Objective of the course:

The course has the basic scope to provide the students with theoretical knowledge about concepts of software quality, about the quality - models, - standards and – methodologies used in software industry. Understanding and usage of the theory is consolidated by the case studies and exercises. By completion of the course, students will be able to understand software quality in its complexity, to see the differences and interconnections among the most popular software quality models, standards, approaches. They will have a solid basis that enables them to make the right selection among software quality models, based on a software company's own characteristics.

4**. Outcome of the course:**

- Understanding of Software Quality
- Detail description of Quality measurement and metrics
- Experimental understanding of Quality plan, implementation and documentation
- Understanding of Quality tools including CASE tools
- Detail description of Quality control and reliability of quality process and Quality management system models
- Gain knowledge of analyzing Complexity metrics and Customer Satisfaction
- Understanding of utilizing the International quality standards – ISO, CMM

5. **Course Plan:**

Component 1	**UNIT -1**	**INTRODUCTION TO SOFTWARE QUALITY**
		Software Quality, Hierarchical models of Boehm and McCall – Quality measurement, Metrics measurement and analysis , Gilb's approach – GQM Model
	UNIT -2	**SOFTWARE QUALITY ASSURANCE**
		Quality tasks, SQA plan, Teams, Characteristics, Implementation, Documentation, Reviews and Audits
	UNIT -3	**QUALITY CONTROL AND RELIABILITY**
		Tools for Quality, Ishikawa's basic tools, CASE tools, Defect prevention and removal, Reliability models, Rayleigh model, Reliability growth models for quality assessment
Component 2	**UNIT-4**	**QUALITY MANAGEMENT SYSTEM**
		Need for standards – ISO 9000 Series, ISO 9000-3 for software development, CMM and CMMI, Six Sigma concepts.
		UNDERSTAND SQA PROJECTS
		Describe components of a software quality assurance system, Describe software quality plans, Relate software quality to the software development life, Describe quality tools & techniques.
		UNDERSTAND SQA MANAGEMENT
		Describe process controls, Agile, MSF, & CMMI, Describe quality metrics, Describe quality costs

REFERENCES:

[1] K. Balla: The Complex Quality World. Developing quality management systems for software companies. Beta Books, Eindhoven University of Technology. 2001. ISBN: 90-386-1003-3

[2] Fenton, N.E., Pfleeger, Sh. L.: Software Metrics: a Rigorous & Practical Approach. International Thomson Computer Press, 1997.
[3] Basili, V.: Applying the Goal/Question/Metric paradigm in the experience factory. In Fenton & Pfleeger, pp. 21-43.
[4] Genuchten, M.van: Towards a Software Factory. Ph.D. thesis, Eindhoven University of Technology, 1991, ISBN: 90 900 4119 2
[5] Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003. (UI : Ch 1-4 ; UV : Ch 7-8)
[6] Stephen H. Kan: Metrics and Models in Software Quality Engineering, Pearson Education (Singapore) Pte Ltd., 2002. (UI : Ch 3-4; UIII : Ch 5-8 ; UIV : Ch 9-11)
[7] Ben, M. et al.: Software Quality, Thomson Asia Pte Ltd, 2003.
[8] Mary B., C., Konrad, M. and Shrum, S.: CMMI, Pearson Education (Singapore) Pte Ltd, 2003. ISO 9000-3, Notes for the application of the ISO 9001 Standard to software development.

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Course Syllabus A Template

1. Name of the Course: Software Security

2. LTP structure of the course: 4 credit [3-1-0]

3. Objective of the course:

This course covers the design and implementation of secure software. Some of the topics covered are the characteristics of secure software, the role of security in the development lifecycle, designing secure software, and best security programming practices. Security for web and mobile applications will be covered. Main objectives of the course are as follows:

1. Current state of software security
2. Common software vulnerabilities
3. Secure software design and coding
4. Software assurance
5. Software security standards and tools
6. Secure software engineering lifecycle
7. Risk management in software development
8. Software security testing

4. Outcome of the course:

1. Explain terms used in secured software development and life cycle process
2. Incorporate requirements into secured software development process and test Software for security vulnerability
3. Identify vulnerable code in implemented software and describe attack consequences
4. Apply mitigation and implementation practices to construct attack resistant software
5. Apply secure design principles for developing attack resistant software
6. How do we understand strategy, how should it be studied and what does it imply for the formulation, implementation and evaluation of strategy within the fields of risk- and security studies?
7. How should security be conceptualized, how should security be studied; and what is the relation between security- and risk studies?

5. Course Plan:

Component 1	**UNIT -1**	**Fundamentals and requirement level analysis**
		Introduction, background of Software security life cycle, Software quality attributes, Security requirement gathering principles and guidelines: A case Study
	UNIT -2	**Introduction of Software Security Types**
		Low Level Security, Defenses Against Low-Level Attacks, Web Security: Attacks And Defenses, Secure Software Development
	UNIT -3	**Security risk management**
		Security Studies and Strategy , Political Risk Analysis, Knowledge

		production and EvaluationSecurity Risk Management, Organization Management and Risk Communication, Transformations of the Public-Private Divide, Intelligence
Component 2	**UNIT-4**	**Introduction of Secure coding techniques**
		Buffer overflow, Format string bug, SQL Injection, Cross -site Scripting, Cross-site Request Forgery Session management Replication of vulnerabilities and exploitation Secure programming for preventing BOF, FSB, SQLI, XSS, session
		Security Design and testing for security, best practices
		Secure software design principles, Static analysis techniques, Security testing (black box and white box and others), Software Security Top 10 Surprises
		Security requirements, validation and verification
		Verification Vs Validation, Verifying and Validating Security Control Requirements, Software reliability, A comparison of security requirements engineering methods

6. BOOK REFERENCES:

[1] Secure and Resilient Software, Mark Merkow and Lakshmikanth Raghavan, CRC Press, ISBN 9781439826973.

[2] Software Security Engineering: A Guide for Project Managers, by Julia H. Allen, Sean J. Barnum Robert J. Ellison, Gary McGraw, Nancy R. Mead, ISBN-10:032150917X, ISBN-13:9780321509178, Pearson Education

[3] Uncover Security Design Flaws Using the STRIDE Approach, by Shawn Herman and Scott Lambert and Tomasz Ostwald and Adam Shostack.

[4] Software [In]security: Software Security Top 10 Surprises, by Gary McGraw, Brian Chess, Sammy Migues

HUMAN COMPUTER INTERACTION- BASKET

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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

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Department of Information Technology

1. Name of the Course: **Advanced Graphics & Animation** (present codes: IAGA630E / IAGA240C)

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 OpenGL, 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

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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:

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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

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Information Technology

Syllabus

6. Name of the Course: Computer Vision
7. 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.
8. 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.
9. 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 PerceptionandProcessing,neuromorphiccomputing.

	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 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.

10. 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.
7. 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.
8. Purves, D. et al (2008) Neuroscience 4th edition. Sinauer Associates, Sunderland, MA

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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

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Syllabus

Name of the Course: Cognition and Cognitive Processes Modeling

1. 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.

	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.
Component 2		**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.

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Department of Information Technology

Course Syllabus

Principles of Interaction Design (PID)

Component	Unit	Topics for Coverage
Component 1	Unit 1	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.
	Unit 2	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.

+ Handouts/ research papers.

ROBOTICS & AI- BASKET

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1. Name of the Course: **Robotics and Industrial Automation**
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 Industrial Automation techniques with Robotics.

4. Outcome of the course: As Robotics has demonstrated its tremendous influence in Industrial Automation, millions of different kinds of Robots are designed, developed and deployed in different kinds of hardware and software industries every day. In the recent years, the penetration of Robots in office and home automation, in IoT, and as cyber physical system has made them Ubiquitous. Thus the students and researchers should acquire knowledge about this important area and must learn how to approach to an automation system design problem using robotics. After undergoing this course they should be better automation system designer. Students will be exposed to the background logical /mathematical techniques involved in Robotics and other automation techniques. 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 as an Robotics and automation system designer.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Industrial Automation: Rigid and Flexible automation, Flexible Manufacturing Module, Flexible Manufacturing System, Computer Aided Design & Manufacturing, Rapid and Virtual Prototyping, Computer Integrated Manufacturing(CIM).
	Unit 2	Concept of KANBAN& Kaizen, Agile, Lean manufacturing, six sigma.
Component 2	Unit 3	Robots and their integration with CIM. Basic definition of Robots –kinematics , mathematical modeling. Trajectory planning, Dynamics, sensing and robot programing for **automation.**
	Unit 4	Mobile Robots and Drones as integral part of automation tools.

. Text & Reference Books:

1. Introduction to Robotics: Mechanics and Control (fourth edition) by John J Craig (text)
2. Robotics: control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International.
3. CIM : Principles of Computer integrated Manufacturing: by Jean-Baptiste Waldner (text)

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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) Principlesof 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

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Department of Information Technology

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
	Unit 4	Monte Carlo Methods, Stochastic Maximum, Likelihood and Contrastive Divergence
	Unit 5	Deep Generative Models: Boltzmann Machine, RBM, Deep Belief Nets, Deep Boltzmann Machine, Convolutional Boltzmann Machine

Text Book:Deep Learning by- Ian Goodfellow, Yoshua Bengio and Aaron Courville,

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

6. References:
www.tensorflow.org

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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:

6. *G.C. Burdea & P. Coiffet*, “Virtual reality Technology, Second Ed.”, Wiley-India.
7. *GJ Kim*, “Designing VR Systems: The Structured Approach”, Springer.
8. *D.A. Bowman* et al., “3D User Interfaces: Theory and Practice”, Addison Wesley.
9. *John Vince*, “Virtual Reality Systems”, Pearson Ed.
10. *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

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Information Technology

Syllabus

11. Name of the Course: Computer Vision
12. 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.
13. 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.
14. 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 PerceptionandProcessing,neuromorphiccomputing.

	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 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.

15. 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.

9. 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.
10. Purves, D. et al (2008) Neuroscience 4th edition. Sinauer Associates, Sunderland, MA

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Department of Information Technology

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

INFORMATION SECURITY- BASKET

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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 andcertain 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	8. 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

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Department of Information Technology

Course Syllabus

Course Code **[Principles of Cyber Security]**

LTP Credit: L:2 T:1 P:0

Objective of the Course: The purpose of this course is to provide the students with the multi-disciplinary overview of cyber security, the importance of considering not only control deployment criteria, the students will also get understanding about the governmental role to protect cyber warfare and how latest technologies are posing threat to the cyber space. Students will be get exposure on function of the Computer Emergency response team and role of ISPs and legal provision constituting crime that may jeopardy the national security.

Outcome of the course: After completing this course the student will get knowledge about the key factors of cyber security and role and challenges to the government.

Component	Unit	Topics for Coverage
Component 1	Unit 1	Context Concepts and Contention: Cyberspace Internet Architecture & Complexity of Security The cyber security threat landscape, history and evolution - Security surfaces; intelligence, case studies, trend analysis - Actors in cyber security; governments, organisations, citizens, criminals – The new global challenges: Evolution of global system; transformation and change; issues of evidence; information, metrics; markets for malware, new players, new rules, shadow of cyberwar; relevance of escalation models, anonymity, and uncertainty; comparisons of “real “ vs. “cyber“ domains.
	Unit 2	Review of Internet architecture; salient points; perspectives of firms, states (national security), individuals, commmunities formal and informal etc., state sponsored vs. private actions does that matter? Layers view and situating actors; noting levels of analysis; and potential sources and targets of threat. International Institutions to Address Cyber Threats The multidisciplinary nature of cyber security - Pervasive passive monitoring - ISPs as intermediaries DP - Principles of secure communications; digital signatures, PKI, encryption, hashing – CERT.

Component 2	Unit 3	**Attacks & Counter Measures:** Failure points and control fields: Introducing control point analysis; illustrating with cases; types of vulnerabilities on Internet and in world politics; reminder of the virtual real contexts and connections; architecture and design norms relevant to cybersecurity issues
	Unit 4	Advanced Persistent Threats - Critical infrastructures - Case study: the Domain Name Systems - Case study: eCash, Bitcoin - Security aspects of social networks, the web science perspective - Management of cyber risks - Multilevel security, Data management - anonymisation and de-anonymisation – DDOS attacks, Ramsonwares, Malwares, Social Engineerings etc Cyber law, regulating the online environment - Computer access offences, data protection law

Part 1:

Part 2:

Text Book:

- P.W. Singer and Allan Friedman, Cybersecurity and Cyberwar: What Everyone Needs to Know (2014, Oxford University Press)
- Nina Godbole, Cyber Security(Wiley India)

Reference Book:

- Nazli Choucri, Cyberpolitics in International Relations (MIT Press, 2012)
- Richard A. Clarke and Robert K. Knake, Cyberwar: The Next Threat to National Security and What to Do About It (Harper Collins 2010)

- Andress, J. (2013). Cyber Warfare: Techniques, Tactics and Tools for Security Practitioners.
- Kugler, Richard L.2008.“Deterrence of Cyber Attacks”. In Kramer, Franklin D., Stuart H. Starr, and Larry K. Wentz, eds, 2009, Cyberpower and National SecurityWashington, DC: NDU Press and Potomac Books, Inc. pp. 309 340

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Course Syllabus

Course Code [Introduction to Information Security Management]

LTP Credit: 2-1-0

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

Outcome of the course: After completing this course the student will get knowledge about the key factors of information security management and its deployment.

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..

Text Book:

- Managing Information Security by j*ohn R. Vacca (Second Edition)*
- *Information Security Risk Assessment Tool Kit by Mark Ryan M. Talabis*

Reference Book

- Building a Practical Information Security Program by Jason Andress and Mark Leary

An information security handbook by Hunter, John M.D

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus

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

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.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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 blockchain 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, Difficulty 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.
- Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts, 2016

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Department of Information Technology

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”

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Department of Information Technology

Course Syllabus

Course Code: ICOFX30E [Computer Forensics]

LTP credit: L:2 T:1 P:0

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, speci cally 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.

Outcome of the Course: Students will understand how to do the investigation of any irregular activities.

Course Outline:

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

Text Book:

Bill Nelson, Amelia Philips, Frank En nger and Christopher Steuart, Computer Forensics and Investigations, First Edition, Thomson Course Technology.

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.

NETWORKS- BASKET

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Department of Information Technology

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; sensorGrid. • 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.

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Department of Information Technology

Course Syllabus

Course Name: Wireless Network Protocols

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.

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Department of Information Technology

Mobile Computing Syllabus

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	**Introduction** • Introduction to Mobile Computing • Issues in Mobile Computing • Applications, limitations, and architecture • Mobile Computing Models • Data link layer considerations(Wireless)
	Unit 2	**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.

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Department of Information Technology

Internet Protocol Syllabus

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 Wireless Networks • 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.
	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**
Component 2	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."**

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Department of Information Technology

1. Name of the Course: Network Operating System

2. LTP structure of the course: 3-0-1

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

b. Operating System Concepts by A*braham Silberschatz Peter B. Galvin and Greg Gagne,* Wiley 8th Edition, 2008.

c.Operating Systems: A Modern Perspective by *Garry. J. Nutt*, Addison-Wesley

d. Modern Operating Systems by*Andrew S. Tanenbaum and Herbert Bros*, Pearson

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Department of Information Technology

1. Name of the Course: Mobile Data Management
2. LTP structure of the course: 2-1-1
3. Objective of the course: Specialized elective. This course is well designed for those students interested in pursuing research/development work in data management in wireless medium.
4. Outcome of the course: Student will get exposure of issues and challenges of data management in wireless systems.
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	*Mobile Software Architectures:* Mobile Computing Models: Mobile Client Server Model, Client/Agent/Server Model, Client/Intercept/Server Model, Peer-to-Peer Models, Mobile Agent Models.
	Unit 2	*Disconnected Operation and Weak Connectivity:* States of Operation, Issues in Disconnected Operations, Data Management in Disconnected state and Weak Connectivity state. Web Browsing Systems. *Case studies (self-study):* CMU's Coda file system, IBM's WebExpress, and Xerox's Bayou weak replication storage system.
Component 2	Unit 3	*Location and handoff management:* Location Lookup, Location Update, Forwarding Pointer Location Management Scheme, Handoff Management, Assignment of Channels.
	Unit 4	*Mobile Transaction Processing:* Architecture, Database Partition and Distribution, Transaction Structure, Serialization of Transactions, Degree of Isolation, Nested Transaction Model *Concurrency Control:* Locking Schemes, The Phantom Problem, Time Stamping, Multi-version Approach.

7. References:

1. Mobile Database Systems by Vijay Kumar, Wiley Publication,

2. Data Management for Mobile Computing by Evaggelia Pitoura, George Samaras, Kluwer Academic

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Department of Information Technology

Course Syllabus

Course Code:[Introduction to Information Security Management]

LTP Credit: L:2 T:1 P:0

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

Outcome of the course: After completing this course the student will get knowledge about the key factors of information security management and its deployment.

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
Component 2	Unit 3	The key elements of Incident management, Software program deficiencies and the vulnerabilities associated with them
	Unit 4	Translating security into a business driver that is critical to meeting the organization's mission. Metrics and Measurement Models

Text Book:

- Managing Information Security by j*ohn R. Vacca (Second Edition)*
- *Information Security Risk Assessment Tool Kit by Mark Ryan M. Talabis*

Reference Book

- Building a Practical Information Security Program by Jason Andress and Mark Leary
- An information security handbook by Hunter, John M.D

COGNITION & RECOGNITION- BASKET

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Syllabus

Name of the Course: Cognition and Cognitive Processes Modeling

4. 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.

5. 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.
6. 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.
	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.
Component 2		**Projects** 3. Hands-on on cognitive architectures. 4. Analysis of cognition of brain using complex networks.

Books:

4. Artificial Mind by Stan Franklin
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. Research papers for brain modeling.

Indian Institute of Information Technology, Allahabad

Information Technology

Syllabus

16. Name of the Course: Computer Vision
17. 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.
18. 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.
19. 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 PerceptionandProcessing,neuromorphiccomputing.

	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 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.

20. 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.
11. 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.
12. Purves, D. et al (2008) Neuroscience 4th edition. Sinauer Associates, Sunderland, MA

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Department of Information Technology

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.
5. 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.

6. 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.

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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**. T**his 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 network, 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:

4. Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.
5. Daphne Koller and Nir Friedman, **Probabilistic Graphical Models: Principles and Techniques**
6. Michael I. Jordan, **An Introduction to Probabilistic Graphical Models,** in preparation. **Course2:**

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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 Extraction Machine Translation

6. References:

6. 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

7. **Recommended Supplementary Text:** Manning and Schütze, Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA: 1999.
8. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.

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Course Syllabus

Course Syllabus:

6. Name of the Course: **Advanced data analytics**

7. LTP structure of the course: 2-1-1

8. Objective of the course: Talks about domain specific mining issues and methods. Large data mining

9. Outcome of the course: Students will get exposure of various methods of performing data mining.

10. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Association mining, Classification and Clustering : Revision. Data Streams mining, Social Network Analysis, Graph mining
	Unit 2	Mining algorithms for large data, Mining Big Data, Hadoop, Map-Reduce, HDFS, Spark + seminars
Component 2	Unit 3	Mining Sequence pattern in TD, Mining Time-series data, , Mining WWW + seminars
	Unit 4	Advanced Machine Learning: Deep Learning, probabilistic learning + seminars

8. 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.

9. 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”

SYSTEMS BASKET

Indian Institute of Information Technology, Allahabad

Department of Information Technology

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 Mutual exclusion
	Unit 2	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 CUDA Introduction 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
iii. Professional C++ by M Gregoire, NA Solter, SJ Kleper (2Ed)

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Department of Information Technology

1. Name of the Course: Compiler Design

2. LTP structure of the course: L:2 T:1 P:1

3. Objective of the course: The purpose of this course is to provide the students knowledge about the construction of compilers and its various phases.

4. Outcome of the course: After completing this course the student will get knowledge about the compiler working process and they can make their own language.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Compiler Structure: analysis-synthesis model of compilation, various phases of compiler, other related basic concepts related to compilers such as interpreters, preprocessors, macros etc. Lexical Analysis & concepts related to Regular expressions and Finite Automata relevant to Compiler construction Syntactic specification of Languages: Context Free Grammar/ language, ambiguity, associatively, precedence, basic parsing techniques, LEX.
	Unit 2	Top-down parsing: Backtracking parser, drawbacks, Top-down parser without backtracking: LL (1) parsing, Problem of Left recursion, Left factoring of Common prefixes, problem solving. Bottom-up parsing: Handle of a rightmost sentential form, Shift-reduce parsing, LR (0) parsing, Conflicts, SLR (1) parsing, limitations, LR(1) and LALR(1) parsing, problem solving, YACC.
Component 2	Unit 3	Semantic Analysis and Syntax Directed Translation: Static & Dynamic Checks, Typical Semantic errors, Scoping, Type Checking; Syntax directed definitions(SDD) & Translation (SDT), Attribute Types: Synthesized & Inherited, Annotated Parse Tree, S-attributed and L-attributed grammar, Ordering the evaluation of Attributes, Applications of syntax directed translation. Symbol Table Design: Function of Symbol Table (ST), Information provided by ST, Attributes of ST, Data Structures for ST: Unsorted list, Sort ed list, Linked list, Search trees, Hash table; Scoping, Methods to deal with Scope.
	Unit 4	Intermediate Code Generator: Syntax tree & DAG representations, Three-address code, Quadruples, Triples, Indirect-triples, SDT for intermediate code, Intermediate code generation for control flow, boolean expressions and procedure calls; Short-circuit code, Back patching and Introduction to run-time environments. Code Optimization: Basic blocks, Flow graphs, Function-Preserving Transformations: common subexpression elimination, copy propagation, dead-code elimination and constant folding; Loop optimizations: Code motion, Induction-variable elimination and Reduction in strength; Peephole optimization e.g. Flow-of-Control optimization, Algebraic simplification; Data flow analysis.

6. Text Book:

- A.V. Aho, M.S. Lam, R. Sethi and J.D. Ullman, Compilers: Principles, Techniques and Tools, 2nd Ed., Pearson,2014.

7. References:

- K.C. Louden, Compiler Construction: Principles and Practice, CENGAGE Learning, 1997.
- J.R. Levine, T. Mason and D. Brown, Lex and Yacc, O'Reilly. Second edition 2012.

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Course Syllabus

1. Name of the Course: Real Time Operating Systems
2. LTP structure of the course: 2-0-2
3. Objective of the course: This course is intended to cover principles and foundations of real-time computing.
4. Outcome of the course:
5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Background, motivation anddefinition of real-time computingCharacterization of real-timesystems; real-time performancemetrics and deadlinesEstimation the execution time ofreal-time tasks, and evaluation ofthe system's ability of meetingdeadlines
	Unit 2	**Real Time Scheduling :** Introduction to task scheduling:task models, classification ofscheduling algorithmsClock-driven scheduling, preemptive vs. non-preemptive,online vs. offline schedulingWeighted round-robin schedulingsporadic and aperiodic taskscheduling, Schedulableutilization, critical instantPriority-driven scheduling: EDF, MLF, RM and DM
Component 2	Unit 3	Time-sensitive communications:protocols and end-to-end delay guarantees, and their implementation. Model-based integration of embedded real-time software: Algorithms, languages, tools and applications.
	Unit 4	Formal methods for specification and verification of embedded real-time systemsFault-tolerance and evaluation techniques for RTC systems: models,algorithms and architectures for error detection, fault isolation,recovery.Real-time extension of general-purpose Oses - RT extension of Windows and Linux

6. Text Book:

a. *Real-Time Systems: Design Principles for Distributed Embedded Applications*, by **Hermann Kopetz**, Springer

b. *Real-Time Systems* by **Jane W. S. Liu,** Pearson India

7. References:

a. *RealTime Systems: Theory and Practice*, **Rajiv Mall,** Pearson India

b. Real-Time Systems Design and Analysis: Tools for the Practitioner, 4th Edition

Phillip A. Laplante, Seppo J. Ovaska

Indian Institute of Information Technology, Allahabad

Department of Information Technology

Course Syllabus

1. Name of the Course: Cyber Physical Systems

2. LTP structure of the course: 2-0-2

3. Objective of the course: The course intends to provide an overview of modeling techniques for CPS/IoT systems, the mapping of applications to execution platforms, the evaluation of (partial) designs and some characteristics of CPS/IoT hardware and software execution platforms.

4. Outcome of the course:

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	**Introduction:** Scope, opportunities & challenges of cyber-physical systems (CPS) **Modeling:** Requirements, models of computation, early phases, Introduction to continuous-time systems; Modeling of physical processes; Linear time-invariant systems; Numerical simulation of differential equations; Petri nets and data flow, Introduction to discrete-time systems and return maps; Finite state machines; Event triggered systems; Stateflow; Timed automata; Hybrid automata; Concurrency; Invariants; Linear temporal logic; Imperative styles, communication libraries, Ptolemy,UML, other modeling paradigms, Special requirements for CPS hardware
	Unit 2	**System software:** Embedded operating systems, resource access protocols **Design evaluation:** Pareto-optimality, quality of results, real-time, calculus, worst case execution time estimation, energy modeling,thermal modeling, dependability, other objectives
Component 2	Unit 3	**Mapping to platforms:**scheduling algorithms for single cores,independent jobs on multiple cores, jobs with precedence constraints (list scheduling, HEFT, integer linear programming, genetic algorithms) **Optimizations:** Scratchpad allocation strategies, Worst-case execution time aware optimization, power aware optimizations
	Unit 4	**Case studies and Full system examples**

6. Text Book:

a. *Embedded System Design*. **P. Marwedel**, 2nd edition, Springer,

b. *Introduction to Embedded Systems: A Cyber-Physical Systems Approach*

Book by **Edward A. Lee and Sanjit Arunkumar Seshia**

7. References:

a. *Principles of Cyber-Physical Systems,* **Rajeev Alur**, MIT Press, 2015

b. Cyber-Physical Systems : Foundations, Principles and Applications, 1st Edition,

Editors: Houbing Song Danda Rawat Sabina Jeschke Christian Brecher

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Department of Information Technology

1. Name of the Course: Introduction to Network Science

2. LTP structure of the course: 2-1-1

3. Objective of the course:

This course describes the fundamental concepts of networks that surround us. Analyzing these networks gives crucial insights into several problems. Understanding the fundamental concepts related to the popular networks in this world and learning various analyzing techniques is the first step towards exploring the science behind networks.

4. Outcome of the course:

The students are exposed to popular types of networks and models to generate these types. This course also covers algorithms and tools to analyze networks and mining various structural information. In the lab component, the students learn visualizing networks and implement various algorithms for analysis of networks.

5. Course Plan:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Background, Properties of many real networks
	Unit 2	Network analysis metrics: Centrality Measures, Clustering coefficient
Component 2	Unit 3	Network models: Random Networks, Scale Free Networks and Small World networks.
	Unit 4	Community detection
	Unit 5	Information Diffusion and spreading phenomenon

6. Text Book:

1. A-L. Barabási, Network Science , available online, 2015.

2. D. Easley and J. Kleinberg, Networks, Crowds, and Markets , Cambridge Univ Press, 2010 (also available online).

7. References:

1. M.E.J. Newman, Networks - An introduction , Oxford Univ Press, 2010.

2. M.O. Jackson, Social and Economic Networks , Princeton Univ Press, 2008.

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Department of Information Technology

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*

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Department of Information Technology

1. Name of the Course Syllabus for Formal verification and application

2. LTP structure of the course:(2-1-1)

3.COURSE OUTLINE

The purpose of this course is to train students in the art and scienceof mathematically proving formally specified properties of computersystems. The primary emphasis will be on theoretical aspects of specification formalisms and algorithmic verification. There will beoccasion to studysome of the issues that arise in deploying these techniques inpractice, and solution strategies for them. Techniques covered in the course should be applicable in both software and hardware(modeled as processes) domains.

The broad outline of the course is as follows:

Component	Unit	Topics for Coverage
Component 1	Unit 1	Motivation for formal verification with examples from hardware andsoftware domains.Notion of state/configuration of a system and transitions betweenstates; operational semantics and state transition systems
	Unit 2	Formally specifying properties of systems using first-order logic andother logical formalisms Hoare logic: formalism, usage and rules for use in proving propertiesof programs.
Component 2	Unit 3	Temporal logics (LTL and CTL) and their use in specifying temporalproperties of reactive systems. Theory of abstract interpretation. Some useful abstract domains andtheir use in program verification and hardware system analysis. Abstract transformers and widening/narrowing operations: use incomputing invariants. Predicate abstraction, Boolean programs andcounterexample-guided abstraction refinement.Use of Craig interpolants in refining predicate abstraction.
	Unit 4	Model checking techniques for CTL and LTL: explicit-state and symbolictechniques based on Binary Decision Diagrams and SAT solvers. Use ofCraig interpolation for unbounded modelchecking of safety properties. Some case studies in program verification and property checking ofhardware systems. Learning Implementation and tools such as NuSMV, Z3, UPPAAL etc.

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