Syllabus for 4 year UG Course
Department of Information Technology, IIEST Shibpur

Course Structure

Third Semester

Sl. No.	CODE	Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	T	P			
1		**Mathematics – III**	3	0	0	3	3	100
2	IT2101	**Core Theory –I: Data Structure and Algorithms**	3	1	0	4	4	100
3	IT2102	**Core Theory –II: Digital Logic and Circuit Design**	3	1	0	4	4	100
4	IT2103	**Core Theory –III: Discrete Mathematics and Graph Theory**	3	0	0	3	3	100
5	IT2104	**Core Theory –IV: Signals and Systems**	3	0	0	3	3	100
		Theory Sub-Total	15	2	NIL	17	17	500
6	IT2171	**Core Lab/Practical – I: Data structure and Algorithm Lab**	0	0	3	2	3	50
7	IT2172	**Core Lab/Practical – II: Digital Logic and Circuit Design Lab**	0	0	3	2	3	50

8	IT2173	Core Lab/Practical – III: Programming Lab	0	0	3	2	3	50
9	IT2191	Seminar/Mini Project: Seminar	0	0	0	2	0	50
		Practical Sub-Total	NIL	NIL	9	8	9	200
		Third Semester Total				25	26	700

Fourth Semester

Sl. No.	code	Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	T	P			
1	IT 2201	Core Theory –V: Communication Systems	3	0	0	3	3	100
2	IT2202	Core Theory –VI: Computer Organization and Architecture	3	1	0	4	4	100
3	IT2203	Core Theory –VII: Computer Graphics	3	0	0	3	3	100
4	IT2204	Core Theory –VIII: Formal language and Automata Theory	3	0	0	3	3	100
5	IT2205	Core Theory –IX: Object Oriented System Design	3	0	0	3	3	100

Sl. No.	CODE	Course Name	L	T	P	Credit	Class Load / week	Marks
		Theory Sub-Total	**15**	**1**	**NIL**	**16**	**16**	**500**
6	IT2271	**Core Lab/Practical – IV: Communication Systems Lab**	**0**	**0**	**3**	**2**	**3**	**50**
7	IT2272	**Core Lab/Practical –V: Computer Organization and Architecture Lab**	**0**	**0**	**3**	**2**	**3**	**50**
8	IT2273	**Core Lab/Practical – VI: Computer Graphics Lab**	**0**	**0**	**3**	**2**	**3**	**50**
9	IT2291	**Core Lab/Practical – VII/Mini Project: Mini Project**	**0**	**0**	**3/0**	**2**	**3/0**	**50**
		Practical Sub-Total	**NIL**	**NIL**	**12/9**	**8**	**12/9**	**200**
		Fourth Semester Total				**24**	**28/25**	**700**

Fifth Semester

Sl. No.	CODE	Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	**T**	**P**			
1	IT 3101	**Core Theory X: Microprocessor and Microcontroller**	**3**	**0**	**0**	**3**	**3**	**100**
2	IT 3102	**Core Theory –XI: Operating Systems**	**3**	**1**	**0**	**4**	**4**	**100**

3	IT 3103	Core Theory –XII: Database Management Systems	3	1	0	4	4	100
4	IT 3104	Core Theory –XIII: Algorithms	3	1	0	4	4	100
5	IT 3105	Core Theory –XIV: Information and Coding Theory	3	0	0	3	3	100
		Theory Sub-Total	15	3	NIL	18	18	500
6	IT 3171	Core Lab/Practical – VIII: Microprocessor and Microcontroller Lab	0	0	3	2	3	50
7	IT 3172	Core Lab/Practical –V: Operating System Lab	0	0	3	2	3	50
8	IT 3173	Core Lab/Practical – VI: Database Management System Lab	0	0	3	2	3	50
9	IT 3174	Algorithms Lab	0	0	3	2	3	50
		Practical Sub-Total	NIL	NIL	12	8	12	200
		Fifth Semester Total				26	30	700

Sixth Semester

Sl. No.		Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	T	P			
1	IT3201	Core Theory –XV: Compiler Design	3	0	0	3	3	100

2	IT3202	Core Theory – XVI: Computer Networks	3	1	0	4	4	100
3	IT3203	Core Theory – XVII: Software Engineering	3	0	0	3	3	100
4	IT3204	Core Theory – XVIII: High performance Computer Architecture	3	0	0	3	3	100
5	IT3205	Core Theory – XIX: Machine Learning	3	1	0	4	4	100
		Theory Sub-Total	15	2	NIL	17	17	500
7	IT3271	Core Lab/Practical –XII: Computer Networks Lab	0	0	3	2	3	50
8	IT3272	Core Lab/Practical –XIII: Software Engineering Laboratory	0	0	3	2	3	50
9	IT3273	Machine Learning Lab	0	0	3	2	3	50
		Practical Sub-Total	NIL	NIL	9	6	9	150
		Sixth Semester Total				23	26	650

Seventh Semester

Sl. No.	CODE	Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	T	P			
1	IT 4101	Core Theory –XX: Information and System Security	3	0	0	3	3	100
2	IT4102	Core Theory –XXI: Internet Technology	3	0	0	3	3	100
3	IT412X	Core Elective - I:	3	0	0	3	3	100
4		Open Elective (HSS)	3	0	0	3	3	100
		Theory Sub-Total	12	0	NIL	12	12	400
5	IT4171	Core Lab/Practical – XIV: Information and System Security Lab	0	0	3	2	3	50
6	IT4172	Core Lab/Practical – XV: Internet Technology Lab	0	0	3	2	3	50
8	IT4191	B.Tech. Project/ Part –I	0	0	2	4	2	100
9	IT4192	Internship (Evaluation)	0	0	0	2	0	50
		Practical Sub-Total	NIL	NIL	8	10	8	150
		Seventh Semester Total				23	26	650

	7th Semester : Core Elective I
IT4121	Soft Computing Techniques
IT4122	Image Processing
IT4123	Graph Algorithms
IT4124	Mobile Communications
IT4125	Embedded Systems
IT4126	Distributed Algorithms
IT4127	Pattern Recognition
IT4128	IoT Systems and Security

Eighth Semester

Sl. No.	CODE	Course Name	Class Load Per week			Credit	Class Load / week	Marks
			L	T	P			
1	IT4201	Core Theory – XXII: Artificial Intelligence	3	1	0	4	4	100
3	IT422X	Core Elective - II:	3	0	0	3	3	100
4	IT426X	Open Elective - I:	3	0	0	3	3	100
		Theory Sub-Total	9	0	NIL	10	10	300
6	IT4291	B.Tech. Project/ Part -2	0	0	2	8	2	200

8	IT4292	Seminar	0	0	0	2	0	50
9	IT4293	Comprehensive Viva	0	0	0	2	0	100
		Practical Sub-Total	NIL	NIL	2	12	2	350
		Eighth Semester Total				22	12	650

CODE	8th Semester : Core Elective II:	CODE	8th Semester : Open Elective I
IT4221	Cloud Computing and Web Service	IT4261	Computational Geometry
IT4222	Real Time Systems	IT4262	Digital Signal Processing
IT4223	Parallel and Distributed Systems	IT4263	Internet of Things
IT4224	Deep Learning	IT4264	Multimedia Systems
IT4225	Data Sciences	IT4265	CAD for VLSI
IT4226	Intelligent Transportation and Smart Systems	IT4266	Cognitive radio networks
IT4227	Multimedia Systems	IT4267	Mobile Computing
IT 4228	Bioinformatics		

THIRD SEMESTER

DATA STRUCTURE AND ALGORITHMS (IT 2101)

L-T-P: 3 – 1 – 0
Prerequisite: Concepts of C Language

Sl. No.	Module Name and Topics	# Lectures
1.	**Introduction:** Functions; arrays; introduction to pointers; structures; dynamic allocation; linked structures; time and space requirements. Algorithm Analysis, Asymptotic notations, Running Time Calculations	4
2.	**Stack:**Abstract Data Types (ADTs), Implementation of vector, Array Implementation Multiple Stacks, Applications and use of Stacks: Conversion from Infix to Postfix, Evaluation of Postfix Expressions, Prefix Notation, etc.	6
3.	**Queue:** Introduction, Liner Queue, Circular Queue, De-queue, Priority Queue, Array Queue Implementation, Applications of Queues, GeneralList.	6
4.	**Linked Lists:** Introduction, pointer and Implementation, Linear Linked Lists, Circular Linked Lists, Doubly Linked Lists, Doubly circular, Implementation of Linked Lists, Linked Stacks and Queues, Application of Linked List: Polynomials, High precision Arithmetic, Josephus Problem, etc.	6
5.	**Recursion:** Recursion Algorithm, Type of Different Recursion Algorithms, Removal of Recursion.	2
6.	**Graph:**Introduction, BFS and DFS, connected components, spanning trees, shortest paths, max flow. **Trees:** Tree Terminology, Binary Tree, Binary Tree Representation, Binary Tree Traversals, Threaded Binary Tree,Binary Search Tree Concepts and Implementation.Heap tree, AVL Tree, Red-Black tree.	10
7.	Hashing: Insert, search, delete, collision resolving techniques	4
8.	**Search Methods:**Linear search, Binary search, Complexities of the searching algorithms.	4
9.	**Sorting:** Introduction to sorting and comparison of Sorting Techniques, Complexities of sorting algorithm.	6
	Total:	**48**

Suggested Reading:
1. Seymour Lipschutz, Data Structures, Schaum's Outlines Series, Tata McGraw-Hill.
2. Ellis Horowitz, SatrajSahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
3. Goodrich, Michael T. & Roberto Tamassia, Algorithm Design, Wiley Singapore.
4. Cormen, Thomash H., Leiserson, Charles E., Rivest, Ronald L., & Stein, Clifford. Introduction to Algorithms.

DIGITAL LOGIC AND CIRCUIT DESIGN (IT 2102)

L-T-P: 3 – 1 – 0
Prerequisite: None

Sl. No.	Module Name and Topics	No. of Classes
1	**Number systems and Codes:** Number representation and Computer arithmetic, Codes	1
2	**Boolean Algebra and Minimization Techniques:** Boolean Logic operations, Basic laws, De Morgan's theorems, SOP/POS, K-map, Quine-McCluskey or Tabular method of minimization	3
3	**Logic Gates:** Logic Gates, Mixed Logic, Multilevel Gating networks, Multilevel output gate networks	2
4	**Logic Families:** Digital Integrated Circuits, Introduction to logic families, CMOS logic	2
5	**Combinational Circuits:** Multiplexers, Demultiplexers, Decoders, Encoders, Parity Generator/Checker, Code converters, Magnitude comparators, Applications	6
6	**Arithmetic Circuits:** Adders and Subtractors, Binary multiplier, Binary divider	6
7	**Flip-Flops:** Latches, Flip-Flops (Clocked SR, JK, D, T), Trigerring of Flip-flops, Realization of one flip-flop using other, Flip-flop ICs, Applications	6
8	**Counters:** Asynchronous (Ripple or Serial) counters, Synchronous (Parallel) counters, Applications	3
9	**Registers:** Universal shift registers, Shift register counters, Sequence generator	2
10	**Memory devices:** Classification, Basic memory structure, ROM, RAM, Memory decoding, Memory expansion, PLD	3
11	**D/A and A/D converters:** Analog and digital data conversions, Basic D/A conversion techniques (weighted resistor, R-2R ladder type etc.), Different A/D converters (Successive approximation, Single slope, Dual slope)	4
12	**Applications of Digital Circuits:** Frequency counter, Dot matrix display system, Digital multimeter etc.	2
13	**Testing issues in the Digital Circuits**	4
	Total	**44**

Suggested Reading:

1. Logic and Computer Design Fundamentals: by Mano, Kime: Pearson
2. Modern Digital Electronics: by Jain: TMH
3. Digital Design: by Mano
4. Digital Fundamentals: by Floyd, Jain: Pearson
5. Digital Circuits and Design: by Salivahanan, Arivazhagan: Vikas
6. Digital Principles and applications (5th Edition) : Leach & Malvino
7. Digital Computer Electronics : Malvino

DISCRETE MATHEMATICS AND GRAPH THEORY (IT 2103)

L-T-P: 3 – 0 – 0
Prerequisite: Preliminary concepts of Sets, Numbers

Sl. No.	Module Name and Topics	No. of Classes
1.	**Logic and Proofs:** Propositions, Conditional propositions and Logical Equivalence, Predicate calculus, quantifiers, Normalization of well-formed-formulas,Method of proofs, mathematical induction.	8
2.	**Language of Mathematics:** Sets, sequences and strings, Number systems, Relations, Equivalence relations, Matrices of relations, partial order sets, well order sets, quasi order sets, lattice. Application to relational Databases, Functions, Inverse and composition of functions, one-to-one correspondence.	6
3.	**Algebraic structures:**Algebraic structures with one binary operation - semigroups, monoids and groups. Free and cyclic monoids and groups, permutation groups, normal subgroups. Algebraic structures with two binary operations - rings, integral domains and fields. Boolean algebra and Boolean ring.	8
4.	**Counting methods:** Basic principles of counting (Inclusion- exclusion, addition and multiplication rules), permutations and combinations, algorithms for generating permutations and combinations, binomial coefficients and combinatorial identities, The pigeonhole principle. Introduction to Polya's theory of counting.	6
5.	**Recurrence relations:** Introduction, recursively defined sequences, solving recurrence relations: the characteristic polynomial and generating functions. Applications to analysis of algorithms.	6
6.	**Graph theory:** Introduction to graphs and their basic properties:degree, paths and cycles, subgraphs, isomorphism, Euler and Hamiltonian paths and cycles, representation of graphs, connected graphs, planar graphs. Basic graph searching algorithms: BFS and DFS. Basics of tree and spanning tree.	7
7	**Coloring of Graph:** graph coloring basics, chromatic number, 4-color problem.	4
	Total:	45

Suggested Reading:

1. Discrete Mathematics and its Applications by Kenneth H Rosen, PHI
2. Discrete MATHEMATICS FOR Computer Scientists, J L Mott, A Kandel, and T P Baker
3. Concrete Mathematics: A Foundation for Computer Science, by Ronald Graham, Donald Knuth, and Oren Patashnik
4. Graph Theory With Applications To Engineering And Computer Science, Narsingh Deo, Tata Mc Graw Hill
5. Graph Theory, F Harary, Narosa

SIGNALS AND SYSTEMS (IT 2104)

L-T-P: 3-0-0
Prerequisite: Vector space, probability and statistics   Full Marks: 100

Sl. No.	Module Name and Topics	Lecture #
1.	**Introduction to signals and systems:** classification and representation, concepts of linear vector space and orthogonal signal representation, classification and properties of signals, System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability	6
2.	Fourier series, Fourier transform and its properties	6
3.	Parseval's theorem, Bandwidth of signals, duality of time and frequency representations of signals.	2
4.	Discrete time signal: sampling, digitization and reconstruction of analog signals, DTFT and DFT.	6
5.	Introduction to random signals and their properties: random variables and processes for characterization and analysis of message signal and noise	6
6.	Random process, classification of random processes, geometric representation of random process, Gaussian random process, auto and cross-correlation, power spectral density.	10
7	Introduction to system and classification, discrete time system, signal distortion in transmission, distortion-less conditions for signal transmission. Linear time invariant (LTI) system, impulse response, convolution, transfer function, Bandwidth of systems. System response to random signals.	8
	TOTAL	**44**

Text Books:

1. Linear Systems and Signals, B. P. Lathi, Oxford
2. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
3. Probability and Random Processes with Applications to Signal Processing- H. Stark, J. W. Woods, Pearson Education Asia

Reference Books:

1: A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals & Systems, Pearson
2: S. Haykin & B.V.Veen, Signals and Systems- John Wiley

DATA STRUCTURE AND ALGORITHM LAB (IT 2171)

Weekly contact: 0 – 0 –3 (L – T – S)   **Full Marks: 50**

Prerequisite: Concepts of C Language

Module Number	Topics	No. of Classes
	Program related to	
1.	pointer, array, structure and union	6
2.	Stack and Queue	6
3.	Linked Lists	6
4.	Recursion and Binary Tree	12
5.	Search Methods	6
6.	Sorting	6
	Total:	42

References:

1. Seymour Lipschutz, Data Structures, Schaum's Outlines Series, Tata McGraw-Hill.
2. Ellis Horowitz, SatrajSahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
3. Goodrich, Michael T. & Roberto Tamassia, Algorithm Design, Wiley Singapore.
4. Cormen, Thomash H., Leiserson, Charles E., Rivest, Ronald L., & Stein, Clifford. Introduction to Algorithms.

DIGITAL LOGIC AND CIRCUIT DESIGN LAB (IT 2172)

1. Introduction. Rules and precautions for hardware laboratory experiments. Demonstrations of basic logic building blocks, trainer kits, IC and components handling.
2. Hands-on experiments and verification of the behavior of different logic building blocks.
3. Logic simplification and minimization, design, implementation, and behavioral verification of different combinational logic units/functions.
4. Design, implementation, and behavioral verification of different sequential logic units/functions.
5. Mini project (small group activity): Design, implementation, and verification of a large digital logic/arithmetic unit for real-world application.

PROGRAMMING LAB (IT 2173)

Module number	Topic	Duration (hour)
1	Basic of Array, Pointer and Function	3
2	Passing array to a function	3
3	Function pointer	3
4	Pointer to a function	6
5	File handling	6
6	Command line argument	3
7	Dynamic memory allocation	6
8	Hardware interfacing	6
	Total	36

FOURTH SEMESTER

COMMUNICATION SYSTEMS (IT 2201)

L-T-P: 3-0-0

Prerequisites: digital logic and circuit design, signals, systems and circuits

Course Objective: Prime objective of the course is to demonstrate various analog and digital communication methods, their utility in practical cases and analysis of real communication channels in presence of noise.

Program Outcome:

1. Students will know about various analog and digital modulation techniques and their comparative performance analysis
2. Noise analysis in digital communication circuits is one of the topics.
3. Students will also learn broadband communication and different spread spectrum techniques.

Sl. No.	Module Name and Topics	# Lectures
1.	**Analog Communication**: Introduction to electrical communication, elements of a communication system	2
2.	Introduction to modulation, Different types of analog modulations, AM, FM, PM with demodulation techniques	4
3.	Different types of analog modulations, Comparative studies and performance analysis, modulation efficiency, SNR effect	4
4.	multiplexing techniques, application of analog modulation	2
5.	**Waveform coding-** PCM, DPCM, and Delta modulation, performance studies	4
6.	Base band shaping for data transmission	4
7.	Nyquist criterion for ISI and eye pattern, equalization	4
8.	**Digital Modulation:** Digital carrier modulation techniques: ASK, FSK, PSK, MPSK	6
9.	**Digital Demodulation:** Coherent and non-coherent detection	2
10.	**Noise Analysis:** PSD and Bit vs symbol error probability and bandwidth efficiency	4
12.	**Broadband Communication:** Introduction to Spread Spectrum modulation, effect on thermal noise, single-tone interference and jamming, process gain	2
13.	**Broadband Communication:** properties and generation of spreading code patterns, DSSS, FHSS, THSS techniques and their comparison	4
	Total	**42**

Books:

1. Modern Digital and Analog Communication Systems, B.P. Lathi , 5th edition, Oxford University Press, USA.
2. Communication Systems, A. B. Carlson, 4th Edition Mcgraw Hill 2002
3. Communication Systems, Simon S. Haykin, John Wiley & Sons, 1983
4. Principles of communication Systems, Taub Schilling, Tata Mc Graw Hill
5. Digital and Analog communication Systems, K. Sam Sanmugam

6. Digital Communications, J. G. Proakis, M. Salehi, 5th edition, McGraw-Hill, New York
7. Modern communication systems and spread spectrum, George R. Cooper, Clare D. McGillen, McGraw-Hill

COMPUTER ORGANIZATION AND ARCHITECTURE (IT 2202)

L-T-P: 3 – 1 – 0
Prerequisite: IT 2102 (Digital Logic and Circuit Design) or any equivalent course

Module #	Module Name and Topics	# Lectures
1	**Computer function and Interconnection:** Computer Components, Computer function, Interconnection structures, Bus interconnection, PCI	2
2	**CPU Arithmetic:** ALU, Integer representation, Integer arithmetic, Floating point representation, Floating point arithmetic.	2
3	**Instruction Sets:** Machine instruction characteristics, types of operands, Types of operations, Assembly language, Addressing, Instruction formats.	4
4	**Processor Design and Datapath:** Processor role, processor design goals, processor design process, datapath organization, main memory interface, local storage/register file, datapath for simple instructions, floating point unit datapath, advanced processors and datapaths.	6
5	**Processor design and control unit:** Role of control unit, reset sequence, interrupt recognition and servicing, abnormal situation handling, instruction cycle and decisions involved, hardwired control unit, microprogrammed control unit.	6
6	**Memory:** Overview of computer memory system, memory parameters, classification of memory, main memory allocation, static RAM IC, Dynamic RAM, ROM logic, multiple memory decoding.	4
7	**Cache:** Cache memory principles, elements of cache design, Cache organization.	2
8	**Internal memory:** Semiconductor main memory, error correction, advanced DRAM organization.	2
9	**External memory:** Magnetic disk, RAID, optical memory, magnetic tape.	2
10	**Input/Output:** External devices, I/O modules, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and processors, External interface: Firewire,	4

		Infiniband, and USB.		
11		**Concurrency in Pipelining and Vector processing:** Performance enhancement strategies, classification of parallelism, multiple functional units, pipelining, vector computing, array processor.	**6**	
		Total	**40**	

Suggested Reading:

1. Computer Architecture and Organization Design Principles and Applications: B. Govindarajalu: TMH
2. Computer Organization and Architecture Designing for Performance: William Stallings: Pearson
3. Computer Architecture A Quantitative Approach: John L. Hennessy and David A. Patterson: ELSEVIER
4. Computer Systems Architecture A Networking Approach: Rob Williams: 2nd Ed: PEARSON
5. Computer Organization and Design The Hardware Software Interface ARM Edition: David A. Patterson and John L. Hennessy: MK

COMPUTER GRAPHICS (IT 2203)

L-T-P: 3-0-0

SI No.	Module name	Topics	# Lectures	# Lectures per section
1.	**Introduction to Computer Graphics :**	Overview of Computer Graphics Computer Graphics Applications and Software	2	6
		Basic graphics I/O devices, overview of Raster and vector graphics display working principle of CRT based display device,	2	
		LCD display device. Introduction to frame buffer, Colour Look Up Table etc..	2	
2.	**Scan conversion – lines, circles and Ellipses; Filling polygons and clipping algorithm**s	Scan Converting Lines: DDA, Bresenham, Mid-point algorithms and Problems of Aliasing Scan Converting Circles and Ellipse	2 1 2 2	14
		Filling Polygons: Flood fill, boundary fill, scan line fill,	2	
		Line clipping algorithms: Cyrus-Beck, Cohen-Sutherland Liang-Barsky	2 1	
		Polygon Clipping algorithms: Sutherland Hodgman and WeilerArtherton algorithm	2	
3.	**Two-**	Transformations and Matrices	2	7

	Dimensional Transformations:	Transformation Conventions Basic 2D Transformations		
		Homogeneous Coordinates and Matrix Representation of 2D Transformations	1	
		Combined Transformations,	2	
		Window-to-Viewport Transformations.	2	
4.	Three-Dimensional Transformations and Projections:	Introduction, Basic transformation matrices in Three-Dimensional Space	2	7
		Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane	2	
		Projections: Orthogonal, axonometric, and oblique.	3	
5.	Visible-Surface Determination:	Techniques for efficient Visible-Surface Algorithms, Categories of algorithms	1	5
		Back face removal, The z-Buffer Algorithm, Scan-line method,	2	
		Painter's algorithms (depth sorting), Area sub-division methods:BSP trees, Visible-Surface Ray Tracing.	2	
6.	Plane Curves and Surfaces:	Curve Representation, Representation of Space Curves:Cubic Splines, Bezier Curves, B-spline Curves.	3	3
		Total		**42**

Suggested Text Books:
1. Computer Graphics Principles & Practice by James D. Foley, Andries van Dam, Steven K. Feiner and John F. Hughes, 2nd Edition in C.
2. Computer Graphics with OpenGL (3/e), D. D. Hearn and M. P. Baker
3. Mathematical Elements for Computer Graphics by Rogers and Adams, McGraw Hill.
4. Computer Graphics (First Indian Edition), Peter Shirley and Steve Marschner, Cengage Learning Reprint of A. K. Peters, 2011

FORMAL LANGUAGE AND AUTOMATA THEORY (IT 2204)

L-T-P: 3-0-0
Prerequisite: Set theory, Digital logic

Sl. No.	Module Name and Topics	# Lectures
1.	**Language and Grammar:** definition, Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages	4

2.	**Finite automata:** Definition, Characteristics, Transitional system, deterministic finite automata (DFA), Nondeterministic finite automata (NFA) , equivalence of DFA and NFA, Dead state, Finite Automata with output, Mealy machine and Moore machine, Conversio, Minimization of finite automata. Myhill-Nerode theorem, Two way finite automata, Application and limitation.	5
3.	**Finite State Machines:** Definition, concept of sequential circuits, state table and state assignments, capability and limitations of FSM, state equivalence & minimization, Incompletely specified machine, Minimal machine, Merger graph, Merger table, Compatible graph.	4
4.	**Regular Expression**: regular sets and regular expressions, Basic operations on regular expressions, Identities, Arden's Theorem, RE to NFA, ε-closure, NFA with ε move to DFA, Regular grammar from RE, pumping lemma for Regular expression, closure properties of regular expression, Decision problems of Regular expression, Application of RE.	5
5.	**Context-free languages and pushdown automata:** Left and right linear grammars. Context-free grammars (CFG) and languages (CFL), parse trees, ambiguity in CFG, inherent ambiguity, Chomsky and Greibach normal forms, closure properties of CFL, pumping lemma for CFL, Application of context free grammar	5
6	Pushdown Automata(PDA), language recognized by PDA, deterministic and non deterministic PDA, equivalence of PDA and CFL, Multi stack PDA	4
7.	**Context-sensitive languages:** Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	2
8	**Turing machines:** The basic model for Turing machines (TM), Mechanical diagram Non deterministic TM.	3
9	Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, concept of undecidability, reducibility, halting problem, Variation of Turing machine, Turing machine as an integer function.	5
10	**Recursive function, Godel number, Ackermann function, mu-recursive, lamda calculus, diagonalization, Concept of P and NP.**	**4**
	Total:	**41**

Books:
1. Hopcroft, J. E., Motwani, R., & Ullman, J. D. (2006). Automata theory, languages, and computation. International Edition, 24, 19, TMH.
2. Martin, J.C (2011).Introduction to Languages and The Theory of Computation, 4th Edition, TMH.
3. Mishra, Chandrasekharan, Theory of Computer Science: Automata, Languages and Computation, 3rd Edition , PHI.
4. Kozen, Dexter C. Automata and computability. Springer Science & Business Media, 2012.
5. Sipser, Michael. "Introduction to the Theory of Computation." ACM Sigact News,1996

OBJECT ORIENTED SYSTEM DESIGN (IT 2205)

L-T-P: 3 – 0 – 0
Prerequisite: Preliminary concepts of Sets, Numbers
This course will cover object-oriented approach to modeling, problem solving, requirement analysis, system design, system implementation, database design, system engineering and software engineering.

Sl. No.	Module Name and Topics	# Lectures
1	**Fundamental concepts of object oriented programming:** Introduction to the principles of object-oriented programming (classes, objects, messages, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers).	6
2	**Object design implementation** in a programming language, e.g., C++ or Java.	8
3	**Object oriented analysis, modeling and design:** UML may be introduced. Use cases, use case driven analysis.	3
4	**Structural modeling** classes, relationships, interfaces, class diagrams, and object diagrams, in UML.	3
5	**Behavioral/Functional modeling** use case diagrams, sequence diagrams, in UML.	2
6	**Dynamic modeling:** State charts	2
7	**Architectural modeling :** Logical architecture: dependency, class visibility, sub systems. Hardware architecture: deployment diagram notations, nodes, object migration between node Process architecture: process and threads and their notations in UML, object synchronization, invocation schemes for threads. Implementation architecture: component diagram notations and examples.	4
8	**Analysis patterns, Design patterns:** Designing objects with responsibilities, Creator, Information expert – Low Coupling, High Cohesion, Controller Design Patterns, factory method, structural, Bridge, Adapter, behavioral Strategy, observer, Applying GoF design patterns, Mapping design to code	4
9	**Reuse:** Reuse of classes, Reuse of components. Reuse of frameworks, black box framework, white box frame. Reuse of patterns: Architectural pattern and Design pattern.	3
10	**System Usability and Measuring User Satisfaction:** Usability Testing, User Satisfaction Test, Developing Usability Test Plans and Test Cases.	2
11	Distributed object model: CORBA and COM / DCOM	2
12	**Object oriented database systems:** Object oriented data model, query languages, storage organization and indexing techniques; object relational databases.	3
	Total	**42**

References

1. Bertrand Meyer, Object Oriented Software Construction, Prentice-Hall.
2. Grady Booch, Object Oriented Analysis and Design, Addison-Wesley.
3. Grady Booch, James Rumbaugh and Ivar Jacobson, Unified Modeling Language Guide, Addison-Wesley.
4. Erich Gamma et al., Design Patterns: Elements of Reusable OO Software, Addison-Wesley.
5. Michael L. Scott, Programming Language Pragmatics, Morgan-Kaufmann.
6. Kim Bruce, Foundations of Object Oriented Languages, Prentice-Hall.
7. Benjamin C. Pierce, Types and Programming Languages, Prentice-Hall.
8. Bjarne Stroustrup, The Design and Evolution of C++, Addison-Wesley.
9. Bill Venners, Inside the JAVA 2 Virtual Machine, McGraw Hill.
10. James E. Smith and Ravi Nair, Virtual Machines, Elsevier/Morgan-Kaufmann.
    Saba Zamir, Handbook of Object Technology, CRC Press.

COMMUNICATION SYSTEMS LAB (IT 2271)

1. Design and study of some basic communication circuits
2. Study of sampling and reconstruction
3. Circuit design and study of various analog modulation techniques
4. Study of waveform coding techniques
5. Experiments on digital modulation techniques ASK, FSK, PSK. Circuit design and study of behaviour of the circuits

COMPUTER ORGANIZATION AND ARCHITECTURE LABORATORY (IT 2272)

1. Know your Computer and its Organization, Hands on demonstration of assembling and disassembling of PC.
2. Hands on experience with different components of computers of different generations, Basic troubleshooting with everyday usage of computers.
3. Introduction to VHDL and Xilinx ISE, Tutorial on VHDL as Hardware Description Language, Tutorial with hands on demonstration in Xilinx ISE Design Tool (Programming Language: VHDL), Build your own Computing Units.
4. Experiments on different combinational design blocks and simulation using VHDL under ISE environment.
5. Experiments on different sequential design blocks and simulation using VHDL under ISE environment.
6. Experiments on designing different computing units for processing, memory, and IO interfacing.
7. Mini project (Group activity): A small project related to Computing Unit design and Simulation.
8. Verify and Test your design: Verification and test of simulated and synthesized design using FPGA Prototype Boards.

COMPUTER GRAPHICS LABORATORY (IT 2273)

Module Number	Topics	Class Load
1	Study of Graphics Card and related hardware	3
2	Overview of OpenGL	3
3	Programming for generating lines, curves and rendered surfaces;	9
4	Geometric transformations and clipping;	3
5	Modeling of objects	3
6	Computer animation	3
Total		24

FIFTH SEMESTER

MICROPROCESSOR AND MICROCONTROLLER (IT 3101)

L-T-P: 3-0-0
Prerequisite(s): Digital Logic and Circuit Design (IT2102) or equivalent course.

Module #	Module Name and Topics	# Lectures
1	**Introduction to 8085A CPU:** Pin description and features, architecture-register organization.	2
2	**8085 Addressing:** Different addressing modes and their features, Instruction set, Instruction cycle, machine cycle, Timing diagram.	3
3	**8085 Assembly Language Programming**	3
4	**Hardware Interfacing:** Interfacing memory, peripheral chips (IO mapped IO and Memory mapped IO), Interrupts and DMA.	4
5	**16 bit processors:** 8086 and architecture, segmented memory cycles, read/write cycle in min/max mode, Reset operation, wait state, Halt state, Hold state, Lock operation, Interrupt processing.	4
6	**8086 Addressing modes and their features:** Software instruction set (including specific instructions like string instructions, repeat, segment override, lock prefizers and their use) and Assembly Language programming with the same.	6
7	**8051 Microcontroller:** Architecture, Memory Management, Instruction set and Assembly Language Programming.	6
8	**ARM RISC Architecture, Memory Management, Instruction set and Assembly Language Programming.**	8
9	**Overview of Raspberry Pi, and Arduino Controller and its application development.**	6
	Total	**42**

Suggested Readings:

1. Microprocessors Architecture, Programming, and Applications with the 8085-R. Gaonkar
2. The Intel Microprocessors- Brey
3. Microprocessors and interfacing: Programming and hardware- Douglas V. Hall
4. The 8051 Microcontroller and Embedded Systems Using Assembly And C, 2/E-Mazidi (Pearson Education India).
5. Advanced Microprocessors and Peripherals - Ajoy Kumar Ray, K M Bhurchandi (TMH)

6. ARM System On Chip Architecture – Steve Furber

OPERATING SYSTEMS (IT 3102)

L-T-P: 3-1-0
Prerequisite(s): Programming and Data Structure, Computer Organization and Architecture

Sl. No.	Module Name and Topics	# Lectures
1.	Introduction: Operating System, Overview, Evolution of Operating Systems, Basic architectural concepts, concepts of batch-processing, multiprocessing, multiprogramming, timesharing, real-time operations; interrupt handler	4
2.	Concept of process, Process synchronization, Process Management and Scheduling, Co-operating processes, Inter-process communication (IPC), Remote procedure call (RPC), Hardware requirements: protection, privileged mode, Threads and their management, Communication in client-server systems.	4
3.	Threads: Multithreaded model, scheduler activations, examples of threaded programs.	2
4.	Scheduling - CPU scheduling— short term, medium term and long term scheduling, non-preemptive and preemptive algorithms;	6
5.	Process Synchronization - The critical section problem, Synchronization hardware, Semaphores, Classical problems of synchronization, Tools and constructs for concurrency,	8
6.	Deadlocks - Modeling, characterization, Detection prevention and avoidance of deadlocks, Recovery from deadlocks, Dynamic resource allocation.	5
7.	Memory Management - Partitioning, paging, concepts of virtual memory, demand-paging, page replacement algorithms, working set theory, load control, segmentation, segmentation and demand-paging, Case studies, Windows. Current Hardware support for paging: e.g., Pentium/ MIPS processor etc.	8
8.	Device Management - Scheduling algorithms -FCFS, shortest-seek-time-first, SCAN, C-SCAN, LOOK, C-LOOK algorithms, Device drivers, concept of driver routines.	3
9.	File Management - File concept, file support, directory structures, symbolic file directory, basic file directory, logical file system, physical file system, access methods, file protection, file allocation strategies.	6
10.	Case Study - UNIX/Linux, Windows, and Android.	2
	Total	**46**

References:
1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, John Wiley,
2. William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall
3. AS Tanenbaum, Modern Operating Systems, 3rd Ed., Pearson
4. AS Tanenbaum, AS Woodhull, Operating Systems Design and Implementation, Prentice Hall
5. M. J. Bach. Design of the Unix Operating System, Prentice Hall of India

6. Harvey M. Deitel (Author), Paul Deitel (Author), David R. Choffnes (Author), Operating Systems , Pearson

DATABASE MANAGEMENT SYSTEM (IT 3103)

L-T-P: 3-1-0
Prerequisite: Programming and Data Structure, Discrete Mathematics and Graph Theory

Sl. No.	Module Name and Topics	# Lectures
1	Introduction Database, Database Management Systems, Database Systems versus File Systems, View of Data, Database Languages, Database Users	4
2	Components of a Database Management System, Data Independence, Network, Relational, Hierarchical, Object Oriented Data Models	4
3	The Entity Relationship Model Basic Concepts, Constraints, Keys, Design Issues, Entity-Relationship Diagrams, Extended E-R Features, Relational Model - Structures of Relational Databases, Integrity Constraints, ER to Relational model	6
4	Relational Query Languages Relational Algebra, Relational Calculus, SQL and QBE.	4
5	Relational Database Design Functional Dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.	6
6	Storage Strategies Ordered, Unordered File, Hashing, Indexing, Single-Level, Multi-level Indexes, B tree and B+ tree	4
7	Query Processing Evaluation of Relational Algebra Expressions, Implementation of SELECT, JOIN, PROJECT Operations, Query Optimization Algorithms.	4
8	Transaction Processing Transaction concept, Schedule, Conflict & View serializabilty, Concurrency Control, Lock base and Timestamp based Protocols, Multiversion and Optimistic Concurrency Control schemes.	8
9	Recovery Causes of failures, Immediate and Deferred Update, Shadow paging	2
10	Advanced Topics Introduction to Web Databases, Distributed Databases, Data Warehouse and Data Mining.	2
	Total	44

References:
1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", Mc Graw Hill, 6th ed, 2013.

2. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson, 7th ed, 2016.
3. C. J Date, "An Introduction to Database System", Pearson, 8th ed, 2003.
4. Ivan Bayross, "SQL, PL/SQL: The Programming Language of Oracle" BPB Publications, 4th ed, 2010

ALGORITHMS (IT 3104)

L-T-P: 3-1-0
Prerequisite: Basic knowledge on Algorithms, and Graph theory

Sl. No.	Module and Topics Name	# of Lectures
1	Models of Computation; Algorithms and Complexity; Best case, worst case and average case; asymptotic notations	6
2	Sorting and searching; search trees; balanced trees; hashing	6
3	Advanced data structure: Red-Black trees, Fibonacci heaps, data structure for disjoint sets	5
4	Lower bound theory	2
5	Optimization problems; Dynamic programming and Greedy method; theoretical foundations of greedy method	6
6	Amortized Analysis, BFS and DFS, connected components, spanning trees, shortest paths, max flow	6
7	Randomized algorithms: identity testing, primality and min cut	4
8	Introduction to complexity classes: P, NP and NP completeness	6
	Total	**41**

Books:
1. Aho, J. Hopcroft and J. Ullman; The Design and Analysis of Computer Algorithms, A. W. L, International Student Edition, Singapore.
2. S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison Wesley.
3. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi.
4. E. Horowitz and S. Sabni: Fundamental of Computer Algorithms, Galgotia Pub. /Pitman, New Delhi/London
5. K. Mehlhom: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin, 1984.

6. A. Borodin and I. Munro: The Computational Complexity of Algebraic and Numeric Problems, American Elsevier, New York, 1975.
7. D. E. Knuth: The Art of Computer Programming, Vol. 1, Vol. 2 and Vol. 3. Vol. 1, 2nd ed., Narosa/Addison-Wesley, New Delhi/London, 1973; Vol. 2: 2nd ed., Addison-Wesley, 18 London, 1981; Vol. 3: Addison-Wesley, London, 1973.
8. S. Winograd: The Arithmetic Complexity of Computation, SIAM.

INFORMATION AND CODING THEORY (IT 3105)

L-T-P: 3-0-0
Prerequisites: Communication Systems, Discrete math and graph theory

Sl. No.	Module Name and Topics	No. of Classes
1	**Introduction:** Data and Information, Communication Channels	2
2	**Basics of Information Theory:** Entropy, Differential Entropy, Relative Entropy, Conditional Entropy, Mutual Information, Channel Capacity	6
3	**Different Models of Sources, Channels and Noise:** Discrete Source, Continuous Source, Memoryless Source, Memoryless Channel, Binary Symmetric Channel, Gaussian Channel, Additive White Gaussian Noise, Markov source	8
4	**Source Coding and Channel Coding:** Source Coding Theorem, Channel Coding Theorem	4
5	**Quantum Information Theory:** von Neumann Entropy, Quantum Relative Entropy, Quantum Joint Entropy, Quantum Conditional Entropy, Quantum Mutual Information	4
6	**Coding Theory:** Block Codes, Cyclic Codes, CRC Codes, BCH and Reed-Solomon Codes, Golay Codes, Convolutional Codes, Majority Logic Decoding, Viterbi Decoding Algorithm, LDPC Codes	12
7.	**STC coding:** Introduction to SISO, MIMO, Space-time coding	4
Total		**40**

Books:

1. Thomas M. Cover and Joy A. Thomas, Elements of Information Theory, John Wiley & Sons, Inc., Second Edition, 2006.
2. Todd K. Moon, Error Correction Coding: Mathematical Methods and Algorithms, John Wiley & Sons, Inc., New Jersey, 2005.
3. Ron M. Roth, Introduction to Coding Theory, Cambridge University Press, 2006.
4. Modern Digital and Analog Communication Systems, B.P. Lathi , 5 th edition, Oxford University Press, USA.
5. Communication Systems, A. B. Carlson, 4th Edition Mcgraw Hill 2002
6. Ranjan Bose , Information Theory, Coding and Cryptography, TMH

MICROPROCESSOR AND MICROCONTROLLER LAB (IT 3171)

1. Study of programs on trainer kit (8085) using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical). Assignments based on theory subject.
2. Familiarization with 8085 simulator on PC. Study of programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the simulator. Assignments based on above.
3. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit eg, subroutine for delay, reading switch state & glowing LEDs accordingly, finding out the frequency of a pulse train etc.
4. Interfacing any 8-bit Latch (e.g., 74LS373) with trainer kit as a peripheral mapped output port with absolute address decoding.
5. Interfacing with I/O modules: ADC, Speed control of mini DC motor using DAC, Keyboard, Multi-digit Display with multiplexing, Stepper motor.
6. Study of programs on 8086 trainer kit using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical). Assignments based on theory subject.
7. Familiarization with 8086 simulator on PC. Study of programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the simulator. Assignments based on above.
8. Assignments based on Assembly Language programming of 8051.
9. ARM MBED based Application Development.

OPERATING SYSTEM LAB (IT 3172)

L-T-P: 0– 0 – 3

Module Number	Topics	Class Load
1	Understanding the time sharing, multiprogramming nature of the operating system	3

2	Inter-process communication using shared memory and message passing	3
3	Thread related programs: scheduling of threads, master-slave model	6
4	Simulation of different scheduling algorithms	6
5	Solving different classical problems of synchronization using semaphores and monitors	3
6	Analyzing the cache/memory behavior of systems (memory mountain etc.), File operation	3
Total		24

DATABASE MANAGEMENT SYSTEM LAB (IT 3173)

L-T-P: 0– 0 – 3

Module Number	Topics	Class Load
1	Creation of Tables using Integrity Constraints in SQL	3
2	Execution of DML statements and Queries in SQL for Small Application.	6
3	PL/SQL Programming for Small Application.	6
4	Programming using Function, Procedure, Cursor and Trigger.	6
5	SQL Application Programming using JDBC/PHP.	3
Total		24

ALGORITHMS LAB (IT 3174)

L-T-P: 0-0-3

1. Study of time requirements of searching and sorting algorithms; Tally the experimental time requirement with the theoretical time complexity; Understanding of problem size
2. Text file compression using Huffman coding
3. Implementation of graph algorithms; Study of data structures' roles in developing efficient algorithms (in connection with graph algorithms)
4. Role of randomness in computing
5. Implementation of some of the number theoretic algorithms

SIXTH SEMESTER

COMPILER DESIGN (IT 3201)

L-T-P: 3-0-0
Prerequisite(s): Formal language and Automata Theory

Sl. No.	Module Name and Topics	# Lectures
1	Introduction: High level and low level language, Compiler, types, challenges in compiler design, phases and passes, language processing system,	2
2	Lexical analyzer, role, issues, Token , pattern, lexeme, lexical errors, input buffering, Regular expression, regular definitions, recognizition of tokens, transitional system, Conversion of RE to NFA-Thomson's construction, Converting RE directly to DFA, Minimizing DFA, Lex compiler	6
3	Formal grammars, and their application to syntax analysis, BNF notation, ambiguity, Removal of left recursion and left factoring Top down parsing, Recursive decent parsing, Predictive parsing, Recursive predictive parsing, Non recursive predictive parsing, LL(1) parsing, First, Follow, LL(1) table constructing, not LL(1), Error recovery in predictive parsing-panic mode and phrase level Bottom up parsing, handle, shift reduce parsing, problems/ conflict in shift reduce parsing, operator precedence parsing, LR parsing, SLR, SLRtable constructing, canonical and LALR, YACC	12
4	Syntax directed transition, syntax directed definition (SDD), Attribute grammar, SDD for type checking, Abstract syntax tree, synthesized and inherited attribute, dependency graph, S and L attribute, Semantic error	6
5	Type checking, Static and dynamic check, type system, type expression, error recovery, specification of a simple type checker,	4
6	Intermediate code generation-advantages, forms of intermediate representation (Syntax tree, DAG, Three address code), Three address code(3AC)- types, quadruples, triple and indirect triple,3AC for relation and logical statement, Boolean expression, condition statement and loop, Backpatching	4
7	Code generation: factor affecting code generation, register allocation, basic block and flow graph, transformation on basic blocks-structure preserving, common sub expression elimination, dead code elimination, renaming temporary variable, algebraic transformation, DAG and basic block, peephole optimization,	3
8	Run time environment: Memory management, Storage organization, static vs dynamic allocation, activation tree, control stack, storage organization, heap allocation, activation records, garbage collection-mark and sweep , reference counting, generation garbage collection,	3

	partial garbage collector.	
	Total	**40**

References:
1. A. V. Aho, R. Sethi and J. Ullman, Compilers: Principles, Techniques and Tools, Addison-Wesley.
2. Steven S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers.
3. David Galles, Modern Compiler Design, Pearson Education.
4. C. Fischer and R. LeBlanc, *Crafting a Compiler*, Benjamin Cummings.
5. A. Appel, Modern Compiler Implementation in C, Cambridge Univ. Press, London.
6. C. Fischer and R. LeBlanc, *Crafting a Compiler in C*, Benjamin Cummings.

COMPUTER NETWORKS (IT 3202)

L - T - P: 3 - 1 - 0
Prerequisite: Basic knowledge on Algorithms, and Graph theory

Sl. No.	Module and Topics Name	# of Lectures
1	Computer networks and their types; a brief history of networking; data switching techniques; an introduction to virtual circuit switched networks and datagram networks; need of layered architecture; ISO-OSI and TCP/IP architecture; task of layers	6
2	Transmission media; bit rate, baud rate and bandwidth; bit encoding techniques; Network topology	4
3	Data link layer (DLL) design issues; Error detection and correction; Flow control; Example DLL protocols – HDLC and PPP; Need of MAC sub-layer; ALOHA and CSMA protocols; Ethernet LAN; HUB, bridge and switch; Switched LAN; an introduction to Token ring LAN and FDDI; DQDB; Wireless LAN	10
4	Need of network layer; Routing algorithms and protocols – RIP, OSPF, BGP; router; routing in Internet; need of logical address; X.25 network, ARPANET and ERNET;	6
5	internetworking; network layer in Internet – IP, ICMP, IGMP, ARP, RARP, DHCP; NAT and CIDR; IPv6	6
6	Design issues of transport layer; socket address; congestion control; TCP and UDP	6

7	Introduction to application layer protocols; SMTP, FTP, HTTP; network management and security	4
	Total	**42**

Books:

1. L. L. Paterson and B. S. Davie: Computer Network, Morgan Kaufman, San Mateo.
2. A. Tannenbaum: Computer Networks, Prentice Hall India.
3. W. Stallings: ISDN and Broadband ISDN With Frame Relay and ATM, Prentice Hall.
4. W. Stallings: Local and Metropolitan Area Networks, Macmillan, New York
5. Kaufman, R. Perlman and M. Speciner: Network Security, Prentice Hall, Englewood Cliffs
6. V. P. Ahuja: Design and Analysis of Computer Communication Networks, McGraw Hill, New York
7. L. Gracial and I. Widjaja: Communication Networks, Tata-McGraw Hill.
8. L. L. Paterson and B. S. Davie: Computer Network, Morgan Kaufman, San Mateo.

SOFTWARE ENGINEERING (IT 3203)

L-T-P: 3-0-0
Pre-requisites: Database Management Systems, Operating Systems, Programming

Sl. No.	Module Name and Topics	# Lectures
1	**Introduction** Software Engineering Discipline and its Evolution, Software Projects vs. Products, Exploratory Style of Software Development, Human Cognitive Limitations, Emergence of Software Engineering.	3
2	**Software Life Cycle Models** Documenting Software Life Cycle, Life Cycle Models, Classical Waterfall Model, Iterative Waterfall Model, Prototyping Model, Evolutionary Model, Spiral Model. Selecting suitable model for software development.	6
3	**Software Requirements Specification** Requirements gathering, Requirements analysis, Software Requirements Specification (SRS), IEEE SRS format, Identifying functional and non-functional requirements, Documenting software requirements specification.	4
4	**Function Oriented Software Design** Design Activities and methodologies, Cohesion and Coupling in software design, Modular Software Design. SA/SD Methodology, Structured Analysis and Building DFD Models, Structured Design, Structure Chart Preparation, Transform and	6

	Transaction Analysis.	
5	**Object Oriented Software Design** Basic Object Oriented Concepts, UML Modelling, UML 2.x.	**2**
6	**Coding** Standards and Guidelines, Code Review Techniques: Code Walkthrough, Code Inspection, Software Documentation, Gunning's Fog Index.	**3**
7	**Testing** Basic software testing concepts, Test Case Generation, Black Box Testing, Equivalence Class Partitioning, Boundary Value Analysis, White Box Testing, Statement, Branch, Condition, Path coverage based testing strategies, Data flow based testing, Mutation Testing, McCabe's Cyclomatic Complexity, Integration Testing, System testing, Error Seeding, Regression Testing. Software testing metrics, Benefits, Metrics life cycle, Types , Process Metrics Product Metrics Project Metrics, Derivative Metrics, Defect Density, Defect Leakage, Defect Removal Efficiency, Defect Severity Index, Review Efficiency, Test Case Effectiveness, Test Case Productivity, Test Design Coverage, Test Execution Coverage, Test Tracking & Efficiency, Test Effort Percentage, Test Economic Metrics, Test Effectiveness, Test Team Metrics, Agile process metrics, Software Testing Key Performance Indicators (KPIs).	**8**
8	**Reliability and Quality Management** Software vs. Hardware Reliability, Reliability Metrics and Growth Models, Software Quality Management, Quality Systems, ISO-900, 9001, SEI CMM Model.	**4**
9	**Software Maintenance [3L]** Software maintenance types, Software maintenance Characteristics, Reverse engineering, Maintenance process models.	**3**
10	**Software Maintenance [3L]** Software maintenance types, Software maintenance Characteristics, Reverse engineering, Maintenance process models.	**3**
11	**Software Project Management [4L]** Project planning, SPMP document, Project Size Estimation, Metrics, Estimation Techniques, Empirical, Heuristic, Analytical techniques, Scheduling, Project Monitoring, Activity networks and Critical Path Method (CPM).	**4**
	Total	**46**

Books:

1. R. Mall, Fundamentals of Software Engineering, Prentice Hall of India, 2nd Ed, 2006.
2. R. S. Pressman, Software Engineering A Practitioner's Approach, Tata McGraw Hill, 6th Ed, 2005.

3. I. Sommerville, Software Engineering, Pearson, 7th Ed, 2005.
4. P. Jalote, An Integrated Approach to Software Engineering, Narosa, 2nd Ed, 1999.

HIGH PERFORMANCE COMPUTER ARCHITECTURE (IT 3204)

L-T-P: 3-0-0

Module #	Module Name and Topics	# Lectures
1	**Overview of von Neumann architecture:** CISC and RISC processors, Instruction set architecture; Architecture, Measuring and reporting performance, Data Path Design.	6
2	**Pipelining:** Basic concepts of pipelining, data hazards, control hazards, and structural hazards; Techniques for overcoming or reducing the effects of various hazards.	6
3	**Hierarchical Memory Technology:** Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.	12
4	**Instruction-level parallelism:** Concepts of instruction-level parallelism (ILP), Techniques for increasing ILP; Superscalar, superpipelined and VLIW processor architectures; Vector and symbolic processors; Case studies of contemporary microprocessors	6
5	**Multiprocessor Architecture:** Taxonomy of parallel architectures; Centralized shared-memory architecture, synchronization, memory consistency, interconnection networks; Distributed shared-memory architecture, Cluster computers. Multi-core architectures.	6
6	**GPU Architecture**	4
	Total	**40**

Suggested Readings:
1. David A Patternson, John L Hennessy- Computer Organization and Design – The HW/SW Interface (The Morgan Kaufmann Series in Computer Architecture and Design)
2. David A Patternson/John L Hennessy- Computer Architecture-A Quantitative Approach- (The Morgan Kaufmann Series in Computer Architecture and Design)
3. Kai Hwang- Advanced Computer Architecture (Parallelism, Scalability, Programmability)
4. J.P. Shen and M.H. Lipasti, *Modern Processor Design* (MCGraw Hill)

MACHINE LEARNING (IT 3205)

L-T-P: 3-1-0
Pre-requisites: Linear Algebra, Probability, Statistics

Module #	Module Name and Topics	# Lectures
1	**Introduction** Learning Problems, Well-posed learning problems, Designing learning systems.	2
2	**Concept Learning** Concept learning task, Inductive hypothesis, Ordering of Hypothesis, General-to-specific ordering of hypotheses. Version spaces, Inductive Bias.	4
3	**Learning Rule Sets** Sequential Covering Algorithm, First Order Rules, Induction, First Order Resolution, Inverting Resolution.	4
4	**Regression** Linear regression, Notion of cost function, Logistic Regression, Cost function for logistic regression, application of logistic regression to multi-class classification.	4
5	**Supervised Learning** Support Vector Machine, Decision tree Learning, Representation, Problems, Decision Tree Learning Algorithm, Attributes, Inductive Bias, Overfitting. Bayes Theorem, Bayesian learning, Maximum likelihood, Least squared error hypothesis, Gradient Search, Naive Bayes classifier, Bayesian Network, Expectation Maximization Algorithm.	10
6	**Unsupervised learning** Clustering, K-means clustering, hierarchical clustering.	4
7	**Instance-Based Learning** k-Nearest Neighbour Algorithm, Radial Basis Function, Locally Weighted Regression, Locally Weighted Function.	6
8	**Neural networks** Linear threshold units, Perceptrons, Multilayer networks and back-propagation, recurrent networks. Probabilistic Machine Learning, Maximum Likelihood Estimation.	6
9	Regularization, Preventing Overfitting, Ensemble Learning: Bagging and Boosting, Dimensionality reduction	4
	Total	**42**

Text Books:

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2e), Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer Science and Business Media, 2009.

3. Pattern Classification (2e), Richard o. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons, 2012.
4. James, Gareth, Daniela Witten, Trevor Hastie, and Robert Tibshirani. An introduction to statistical learning. Vol. 112. New York: springer, 2013.
5. **Christopher** M. **Bishop**. Machine learning and pattern recognition. Information science and statistics. Springer, Heidelberg. 2006.
6. Tan, Pang-Ning, Michael Steinbach, and Vipin Kumar. Introduction to data mining. Pearson Education India, 2016.

COMPUTER NETWORKS LAB (IT 3271)
L-T-P: 0-0-3

1. Setting up of LAN
2. Internetworking using a router
3. Understanding and implementation of basic socket programming
4. Network analysis using raw sockets
5. Writing client server programs under various scenarios
6. Study and analysis of congestion control in a real scenario
7. Implementation of denial of service and other attacks

SOFTWARE ENGINEERING LAB (IT 3272)
L-T-P: 0-0-3

1. Development of ER model of an information system.
2. SRS preparation following IEEE standard
3. Data Flow Modelling of information systems
4. UML Modelling of information systems
5. Implementation of the system incorporating above design models
6. Trace back to SRS for system verification
7. Formal modelling of safety critical systems (using Z, Petrinet etc.)

MACHINE LEARNING LAB (IT 3273)
L-T-P: 0-0-3

1. Basics of neural networks and related problems
2. Solving regression problems
3. Supervised learning for classification
4. Feature selection techniques and applications
5. Unsupervised learning - clustering
6. Ensemble techniques - Bagging and Boosting
7, Bayesian network
7. Reinforcement algorithm

SEVENTH SEMESTER

INFORMATION AND SYSTEM SECURITY (IT 4101)

L-T-P: 3-0-0

Prerequisite(s): Number Theory

Module #	Module Contents	# Lectures
1	**Basics of Security and Cryptography: (3L)** Three major goals of security, major security attacks, security services related to three goals of security, security mechanisms, cryptography and steganography. Cryptanalysis attacks, classes of cryptanalysis attacks.	3
2	**Mathematical Background: (3L)** Introduction to Number theory, Modular arithmetic, Prime number generation, Primality Testing, GCD, Euclidean Algorithm, Extended Euclidean Algorithm, Chinese Remainder Theorem, Fermat's Little Theorem and Euler's Theorem, Index of Coincidence.	3
3	**Private Key Cryptography: (8L)** Symmetric Key Encryption. Definitions. Block ciphers and Stream ciphers. Substitution Ciphers and Transposition Ciphers. Traditional Ciphers vs. Modern Day Ciphers. Chosen-Plaintext Attack. Chosen-Ciphertext Attack, Known-Plaintext Attack. Known-Ciphertext Attack, Pattern Analysis Attacks, Statistical Attacks. Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES. Modes of operation of block ciphers (ECB, CBC, CFB, OFB, Counter modes).	8
4	**Public Key Cryptosystems: (6L)** RSA, ElGamal, Elliptic curve cryptosystems, Public Key Infrastructure (PKI), Digital Signatures, Digital Certificates, Key Management and Key Distribution techniques.	6
5	**Message Authentication and Integrity Verification: (8L)** Message Authentication Codes, Modification Detection Codes, Hash Functions, Cryptographic Hash Functions, Merkle Damgard Scheme, Preimage Resistance, Second Preimage Resistance, Collision Resistance, Random Oracle Model. Digital Signatures, RSA Digital Signature.	8
6	**Entity Authentication: (4L)** Differentiate between message authentication and entity authentication, Data origin vs. entity authentication, Verification categories, Password based authentication, Challenge-response based authentication, Zero-knowledge authentication, biometric authentication.	4
7	**Key Management: (3L)** Key Distribution Center (KDC), Symmetric key agreement protocol, Kerberos as a KDC, Certification Authorities for Public Keys, Role of Public Key Infrastructure.	3

8	**Network Security: (6L)** Security protocol at application level: PGP, SHTTP, SSH etc. Security protocol at socket level: SS/TSL. Security protocol at network level: IPSec.	6
	Total	**41**

Reading:

1. Behrouz A. Forouzan and D. Mukhopadhyay - Cryptography & Network Security, McGraw Hill.
2. Douglas R. Stinson, Cryptography: Theory and Practice, Chapman and Hall.
3. **William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall.**

INTERNET TECHNOLOGY (IT 4102)

L-T-P: 3-0-0
Pre-requisites: Computer Networks

Sl. No.	Module Contents	# Lectures
1.	Review of TCP/IP Protocol Stack: IPv4, IPv6, TCP, UDP, ARP, ICMP, SMTP etc.	4
2.	Internet as a Distributed System, Transparency and Openness in Internet, RFCs	2
3.	Naming in Internet, Name servers, ISP, Governing bodies	2
4.	World Wide Web as a Distributed Document Based System, Client-Server Architecture in Web, Browser	2
5	Web Technologies: Three Tier Web Based Architecture; Jsp, Asp, J2ee, .Net Systems	4
6.	Document Model: Markup languages, Document types, Designing Website, HTML, Sgml, DTD, DHTML	4
7	Cascading Style Sheets: Syntax ,Class Selector, Id Selector Dom (Document Object Model) & Dso (Data Source Object) Approaches To Dynamic Pages: Cgi, Java Applets, Plug Ins, Active X, Java Script – Java Script Object Model, Variables-Constant – Expressions, Conditions-Relational Operators- Data Types – Flow Control – Functions & Objects-events and event handlers – Data type Conversion & Equality – Accessing HTML form elements Basic of XML	4
8.	Communication: HTTP, Web Clients and Servers, Proxies, port, URL	6
9.	JAVA – a language of Internet, Client-side and Server-side Programming	4
10.	Internet bot, Web crawler and Search engines	4
11.	Website Planning & Hosting, Introduction to Internet of Things and web	4

	security	
12	Recent trends in Web Technology	2
	Total	**42**

References:

1. Jeffrey C.Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education
2. Andrew S. Tannenbaum and Maarten van Steen. Distributed Systems: Principles and Paradigms. Prentice Hall, 2nd Edition
3. Bruce Croft, Donal Metzler and Trevor Strohman. Search Engines: Information Retrieval in Practice. Pearson Education
4. Godbole and Kahate, Web Technology, TMH
5. Internet & Intranet Engineering,- Daniel Minoli, TMH.

SOFT COMPUTING TECHNIQUES (IT4121)

L-T-P: 3-0-0

Prerequisite: Discrete mathematics, Calculus: Integration and Differentiation, Concepts of Algorithm and Programming.

Sl. No.	Module name with Topics	No of Hours
1	Introduction: Limitations of Artificial Intelligence; Definition of Soft Computing; Difference between Hard and Soft Computing; Domain soft computing techniques; Introduction to Fuzzy Systems, Artificial Neural Network, Genetic Algorithm, Hybrid Systems	2
2	Fuzzy Logic System: Fuzzy Set Theory, Fuzzy Relation, Fuzzy Logic and Approximate Reasoning, Fuzzy logic system design, Applications	18
3	Artificial Neural Network (ANN): Basic electrical model of ANN, NN Architectures, Learning algorithms and paradigms, Learning Single layer and multilayer perceptions, Hopfield NN and Associative Memory, SOM Models and related algorithms, Applications	18
4	Genetic Algorithm: Difference between Traditional Algorithms and GA, Encoding, Fitness Function, Reproduction, Cross Over, Mutation, Applications.	4
	Total Hours	**42**

TEXT BOOK:

1. Neural networks A comprehensive foundations, Simon Haykin, Pearson Education 2nd Edition 2004

2. Neural Fuzzy Systems- A Neuro-Fuzzy Synergism to Intelligent System, C.T. Lin and George Lee, Prentice Hall
3. Genetic Algorithms in Search, Optimization and Machine Learning, David E. Goldberg,

REFERENCE BOOKS:

1. Artificial neural networks by B.Vegnanarayana Prentice Halll of India P Ltd 2005
2. Neural networks in Computer intelligence, Li Min Fu TMH 2003
3. Neural networks, James A Freeman David M S kapura Pearson Education
4. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.
5. Uncertain Rule-Based Fuzzy Logic Systems: Introduction and New Directions, Jerry M. Mendel,
6. Fuzzy Logic with Engineering Applications, Timothy. J. Ross
7. Fuzzy Sets and Fuzzy Logic – Theory and Applications, G. J. Klir and Bo Yuan, Prentice Hall India

IMAGE PROCESSING (IT 4122)

L-T-P: 3 – 0 – 0
Prerequisite: Signals, Systems and Circuits, Digital Signal Processing, Discrete Math

Sl. No.	Module Name and Topics	No. of Classes
1.	**Introduction**: Image definitions. Image representation: monochrome and color models, image file formats; image digitization, sampling and quantization, image resolution. Image Enhancement & Feature Extraction, Image Analysis and pattern Recognition	4
2.	**Image processing tools:** Fourier, Hadamard-Walsh, Discrete cosine, wavelets and multiresolution analysis; mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations	8
3.	**Image Enhancement**: Filters in spatial and frequency domains, histogram-based approaches, smoothing, edge enhancement and image sharpening filtering, Homomorphic filtering.	8
4.	**Image Restoration** - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and constrained least square method.	6
5.	**Segmentation:** Pixel classification, Bi-level thresholding, multilevel thresholding, split and merge algorithm, region growing, texture and entropy-based methods.	6

Sl. No.	Module and Topics Name	# Lectures
6.	**Image compression**: requirements and types, Statistical and spatial compression techniques like RLE, PCM, Huffman coding etc. Transform coding algorithm-DCT, Concept of Hybrid coding, (Quantization and sampling, Uniform quantizer and non uniform quantizer, Concept of JPEG and MPEG standards)	4
7	**Color Image Processing:** Color Representation, Laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection	4
8	**image reconstruction and retrieval: Introduction to compressed sensing (CS), CS image reconstruction, content based image retrieval**	**4**
	Total	**44**

Books:
1. Digital Image Processing: Rafael Gonzalez and Richard E. Woods, Pearson
2. Digital Image Processing and Analysis: Chanda and Dutta Majumder, PHI
3. Digital Image Processing: A practical introduction using JAVA: Nick Efford, Pearson Education

GRAPH ALGORITHMS (IT 4123)

L - T - P: 3 - 0 - 0
Prerequisite: Basic knowledge on Algorithms, and Graph theory

Sl. No.	Module and Topics Name	# Lectures
1	Graph Traversal - BFS, DFS, Topological Sorting, Applications	2
2	Minimum Spanning Tree	3
3	Shortest Paths	4
4	Network Flows, Applications	4
5	Matching on Bipartite Graph, Applications	3
6	Eulerian and Hamiltonian Tours	3
7	Planar Graphs, Panarity Testing	4
8	Graph Partitioning and its Applications	4

9	Clique Partitioning	3
10	Connected Components and its Applications	4
	Total	34

Books:
1. Combinatorial Optimization, Theory and Algorithms (KV) by Bernhard Korte and Jen Vygen, Springer, 4th Edition (2008). (GMU's libraries have online versions of this book.)
2. Networks, Crowds, and Markets: Reasoning about a Highly Connected World by David Easley and Jon Kleinberg, Cambridge University Press, (2010).
3. Introduction to Graph Theory by Douglas B. West, 2nd Edition (2000).
4. Combinatorial Optimization: Algorithms and Complexity by C. H. Papadimitriou and K. Steiglitz, Englewood Cliffs, Prentice Hall, c1982, Reprinted by Dover Books, (1998).
5. Algorithm Design (KT) by Jon Kleinberg and Eva Tardos, Pearson Education, Inc. (2006).
6. Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, The McGraw-Hill Companies, 2nd Edition (2001).

MOBILE COMMUNICATIONS (IT 4124)

L-T-P: 3-0-0
Prerequisite: Communication systems, computer networks
Outcome: Students will know about wireless communication techniques, different generations of wireless communication and some modern mobile communication techniques.

Sl. No.	Module Contents	# Lectures
1.	**Introduction:** Introduction to mobile and radio communication, radio communication principles, ideas on transmitters, receivers, medium of signal propagation	2
2.	**Cellular concept:** Frequently assignment, frequency reuse, concept of cell splitting, System capacity and interference	4
3.	**Mobile radio propagation:** Multipath signal propagation model and signal fading in mobile environment, large scale path loss	4
4.	**Mobile radio propagation:** Small scale fading and multipath, Doppler effect	2
5.	Receiver techniques for fading dispersive channels: Channel equalization, adaptive equalizing, diversity techniques.	2
6.	Satellite link design: uplink, downlink, G/T ratio, (C/N), performance	4
7.	**Multiple access schemes in mobile communication:** TDMA, FDMA, CDMA, OFDM, Spread Spectrum Transmission and Reception	4
8.	**GSM architecture:** Mobility management, Handover in cellular systems , Soft handover, hard handover, Security, international roaming for GSM,	6

9.	**WLAN:** architecture, ideas on mobile ad-hoc networking, protocols.	6
10.	Introduction to 5G LTE	2
	Total	**36**

Books:
1. T. S. Rappaport, "Wireless Communication: Principles and Practice", PHI, Second Edition
2. Jochen Schiller, "Mobile Communications", PHI, Second Edition, 2003.
3. Jochen Burkhardt, Pervasive Computing: Technology and Architecture of Mobile Internet Applications, Addison Wesley Professional; 3rd edition, 2007
4. T. Pratt, C. Bostian, "Satellite Communication", 2nd Edition, John Wiley Co.
5. William Stallings, "Wireless Communications and Networks", Pearson Education, 2002

EMBEDDED SYSTEMS (IT 4125)

L-T-P: 3-0-0
Pre-requisites: A first course on Digital Logic and Circuit Design, Basic knowledge of microprocessors, microcontrollers (essential), Basic programming concepts (desirable)
Course Objective: Primary objective of this course is to introduce the concepts of necessity, characteristics, design, and detailed working principles of an embedded system dominating each electrical/electronic and computing application sector in industry.
Program outcome:
1. Students will get a first-hand introduction towards the basic design as well as working principle of embedded systems.
2. Details regarding different components used as building blocks in an embedded system should be introduced to the reader.
3. Both electronic/electrical aspects as well as programming aspects to be introduced to get the entire working flavour of the system.
4. Different simple case studies taken from different application sectors to be introduced to prepare the students ready for the real-life applications of such systems.

Module #	Module Name and details	# Lectures
1	**Introduction to Embedded System** Definition of Embedded System & its classification, characteristics of embedded systems, design parameters/Metrics of embedded systems. Components of embedded systems with review of Microprocessor & Microcontrollers, introduction to embedded processor, Digital signal processor, Application specific system processor, Multiprocessor systems using General Purpose Processor.	10

2	**System Processor** Standard Single purpose processors: Peripherals, Introduction, Timers, Counters and watchdog Timers, UART, Pulse Width Modulators, Clocking unit, Real Time Clock Reset Circuitry. Processor and memory organization, processor and memory selection, Memory Types, Memory map and addresses.	8
3	**I/O Interfacing** I/O devices: ADC/DAC, Optical Devices such as LED/LCD Display devices, Keyboard controller, Timer & counting devices, serial communication using I2C, SPI,CAN, RS232, & USB. Device drivers & interrupt service Mechanism: ISR concepts and ISR handling mechanisms	8
4	**Programming Concepts, Embedded System Programming C & C++** Assembly language high level lang. C program Elements, Micros & Function, Data types, Data Structures, Modifiers, Statement, loops & Pointers, queues & Stacks, List & order list, Embedded System Programming in C++. C Program Compilers & Cross Compilers. In Circuit emulator.	6
5	**Overview & Applications of Embedded System** Simple case studies from different application sectors of electrical/electronic/computing etc [e.g. Vending machine system, adaptingCruise control System in a car, SmartCard, Digital camera etc].	8
	Total	**40**

Text Books:
1. Embedded System Design A Unified Hardware/Software Introduction (3e) - by Frank Vahid / Tony Givargis - Wiley India
2. Embedded systems architecture, programming and design (2e) - by Raj Kamal – TMH

Reference Books:
1. Introduction to Embedded Systems (2e) – by Shibu K V, McGraw Hill Education (India)
2. Computer Organization and Embedded Systems (6e) – by Carl Hamacher et al, McGraw Hill International
3. Embedded Systems – Concepts, Design and Programming - by Dave and Dave, Pearson
4. Embedded/Real Time Systems: Concepts, Design and Programming – by Prasad, Dreamtech Press
5. Embedded Microcontrollers and Processor Design – by Osborn, Pearson
6. Embedded Systems Architecture – by Noergaard, ELSEVIER
7. Embedded System Design for students – by Verma, SPD
8. Designing Embedded Hardware – by Catsoulis, SPD, O'Reilly

DISTRIBUTED ALGORITHMS (IT 4126)

L-T-P: 3-0-0
Prerequisite: Algorithms

Module #	Module Contents	# Lectures
1	Introduction: Characterization of Distributed Systems, Network OS vs. distributed OS, Middleware	4
2	Remote Procedure Call: Design issues for RPCs, Case study: Sun RPC; Remote method invocation and JAVA	4
3	Logical clock; Election algorithms; Lower bounds for synchronous networks; Synchronization; Mutual exclusion algorithms	8
4	Distributed Shared Memory: Shared memory, Consistency models, Design issues, Case studies: Ivy/Munin/Treadmarks	6
5	Distributed Consensus and Fault tolerance	6
6	Distributed Naming Services: Names, addresses, routes, capabilities, Naming facilities, name distribution, name resolution, Migration	4
7	Security in Distributed Systems: Basic concepts of Cryptographic techniques	4
8	Distributed Algorithms for Mobile Environment	4
	Total	**42**

References:

1. Nancy Lynch. Distributed Algorithms. Elsevier.
2. Gerard Tel. Introduction to Distributed Algorithms. Cambridge University Press.
3. Ajoy D. Kshemkalyani and Mukesh Singhal. Distributed Computing: Principles, Algorithms, and Systems. Cambridge University Press

PATTERN RECOGNITION (IT 4127)

L-T-P: 3 – 0 – 0
Prerequisite: Signals, Systems and Circuits, Digital Signal Processing, Discrete Math.

Sl. No.	Module Name and Topics	# Lectures
1.	**Pattern Recognition**: Introduction and overview of different approaches to PR, decision boundaries, discriminant functions	2

2.	**Mathematical preliminaries for PR** **Probability**: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. **Linear Algebra**: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors.	6
3.	**Bayes Decision Theory**: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features	6
4.	**Parameter Estimation Methods** : Maximum-Likelihood estimation :Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case.	4
5.	**Unsupervised learning and clustering** - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs	8
6.	**Nonparametric techniques for density estimation**. Parzen-window method. K-Nearest Neighbour method.	4
7	**Dimensionality reduction**: Principal component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalised eigen analysis. Eigen vectors/Singular vectors as dictionaries.	4
8	**Artificial neural networks**: Multilayer perceptron - feedforwark neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.	8
	Total	**42**

Books:

1 R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 20012.

2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

3. J. T.Tou and R. C. Gonzalez, Pattern Recognition Principles, Adison-Welesly, London

4. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

IoT SYSTEMS AND SECURITY (IT 4128)

1. Introduction: Introduction and overview of IoT technology.   2L

2. Design principles for connected devices: Technology requirements, design challenges, principles, and metrics, privacy preservation, web thinking for connected devices.   4L

3. Internet principles:Overview of Internet communication, IP addresses, MAC addresses, TCP and UDP ports, Application Layer Protocols.   6L

4. Prototyping concepts: Sketching, Familiarity, Costs vs Ease, Production aspects, Open source vs Closed source.   4L

5. Embedded Devices: Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, Electric Imp, Mobile Phones, and Tablets, Plug Computing.   10L

6. Physical Design and Online Components: Basic concepts of physical design aspects, tools, and techniques. Online components, API (existing and new), Real-time reactions, Other protocols.
                                                                                        6L

7. IoT Systems security:
Privacy preservation techniques, the device to system-level security in software, Cyber-Physical Systems, hardware security challenges, and techniques.   8L

Total: 40L

INFORMATION AND SYSTEM SECURITY LAB (IT 4171)
L-T-P: 0-0-3
1. Implementation of private key cryptosystems - Block ciphers: such as additive, multiplicative, affine, playfair, vigenere, hill, rotor ciphers.
2. Implementation of private key cryptosystems - Stream cipher: LFSR.
3. Modern day block ciphers: DES and AES.
4. Modes of block cipher operation: ECB, CBC, CFB, OFB etc.
5. Substitution Permutation Networks (SPN)
6. Keys and Keyless Transposition Ciphers
7. Implementation of RSA public key cryptosystem
8. Ciphertext only, known plaintext, chosen plaintext, known ciphertext, chosen ciphertext attacks
9. Cryptographic hash: MD, SHA.
10. Digital Signature Schemes and exploring role of TTP in Digital Signature.
11. Chinese Remainder Theorem

INTERNET TECHNOLOGY LAB (IT 4172)
L-T-P: 0-0-3

Sl. NO	Topic	Laboratory hour
1	**HTML**	**3**

2	**CSS**	**3**
3	**DHTML**	**3**
4	**JAVA script**	**3**
5	**XML**	**3**
6	**Three tier architecture design**	**9**
6	**PHP with MySQL**	**9**
	Total	**33**

Reference Book:

1. HTML & CSS: The Complete Reference, Fifth Edition, Book by Thomas Powell, Mc Graw Hill
2. JavaScript: The Good Parts, Book by Douglas Crockford, OREILLY
3. Learning JavaScript, Book by Shelley Powers, OREILLY
4. PHP and MySQL Web Development, Book by Luke Welling, PEARSON
5. Beginning XML Paperback, David Hunter, Jeff Rafter, Joe Fawcett, WROX

EIGHTH SEMESTER

ARTIFICIAL INTELLIGENCE (IT 4201)

L-T-P = 3-1-0
Pre-requisites: Algorithms, Discrete Maths

Module #	Module Contents	# Lectures
1	Introduction: Overview of AI, agents & environment, Nature of environment, Different types of agents.	3
2	Problem solving**:** Problem, State space, Solving problems by searching, Uninformed and informed search, Breadth first search, Depth first search, Bi-directional search, Iterative deepening search	5
3	Heuristic search: Hill climbing, Best first search, Branch and bound, A* algorithm, Admissibility and monotonicity of A*, Iterative deepening A*, Simulated Annealing, Constraint satisfaction problem	8
4	Adversarial search: Games, Optimal decisions & strategies in games, Minimax algorithm, Alpha-Beta pruning.	3
5	Knowledge and Reasoning: Knowledge representation issues, Predicate Logic, First order logic and WFFs, Forward reasoning ,Unification, Resolution refutation in FOL, Backward reasoning, Structured knowledge representation, Semantic networks, Frames.	7
6	Introduction to logic programming : Basic knowledge of Prolog programming	4
7	Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Shafer theory	4
8	Planning: Components of a planning system, Forward and backward state space planning, Goal stack planning, Hierarchical planning.	4
9	Learning: Concept of learning , learning by induction , explanation-based Learning, introduction of neural networks.	2
10	Expert Systems: Expert system architectures, Expert system shells knowledge acquisition.	2
	Total	42

Suggested Readings:

1. Ritch & Knight, Artificial Intelligence, TMH
2. Stuart Russel Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson
3. Patterson, . Introduction to Artificial Intelligence & Expert Systems, PHI
4. N. J. Nilsson. Artificial Intelligence : A New Synthesis, Elsevier India
5. Ivan Bratko, PRPLOG: Programming for Artificial Intelligence, Pearson

CLOUD COMPUTING AND WEB SERVICE (IT 4221)

L-T-P: 3 – 0 – 0
Prerequisite : Computer Network

Module #	Module Contents	#Lectures
1	**BASIC** Definition, private, public and hybrid cloud. IaaS, PaaS, SaaS. Benefits and challenges of cloud computing	2
2	**CLOUD STORAGE INFRASTRUCTURES** Storage strategy and security regulation; Securing storage in cloud environments. Monitoring and management; security auditing, Security information and event management (SIEM), Storage network design, NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), Software Defined Networks	6
3	**CLOUD SECURITY** Different terms in cloud security, Infrastructure Security:Network and host level security, Application level security Data security and Storage: privacy and security Issues, Jurisdictional issues raised by Data location Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model,	10
4	**IaaS** definition, virtualization and its different approaches, Virtual machine, Resource virtualization, Storage as a service, Hypervisors, Machine Image, Virtual Machine(VM), Examples:Amazon Web Services, Microsoft Azure, Google Compute Engine (GCE) **PaaS** Basic, SOA, SOAP,REST, Protobuf, Micro Services, Cloud platform and management Examples:Google App Engine, OpenShift, Microsoft Azure **SaaS** Introduction, Web 2.0, Web O	10

	Examples:Google Apps, Dropbox, Salesforce, Cisco WebEx	
5	Case studies of different open source and commercial clouds	8
	Total	**36**

Books:
1. *Cloud computing, a practical approach*, Velte, Toby, Anthony Velte, and Robert Elsenpeter. McGraw-Hill, Inc., 2009.
2. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012
3. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

REAL TIME SYSTEMS (IT 4222)

L-T-P : 3 - 0 - 0
Prerequisite: Basic knowledge on OS and networks.

Sl. No.	Module Name and Topics	# of Lectures
1	**Introduction:** Introduction to idea of real time and real time systems. Examples Real time applications, Hard vs. soft real time systems.	2
2	**Reference model of real time systems:** Processors and resources, Tasks and their timing parameters, precedence constraints and data dependency	4
3	**Real Time scheduling:** Different Approaches- Clock Driven, Priority Driven, Scheduling of Periodic and Sporadic Jobs in Priority- Driven Systems.	8
4	**Resource access Management:** Resources and Resource Access Control, Critical Section, Priority-Ceiling Protocols, concurrent Access to Data Objects.	8
5	**Real Time OS:** RTOS Overview, RTOS Components, Task Management & Memory Management, Intertask Communication and Synchronisation, Kernels, Commercial Real-time Operating Systems.	8
6	**Real time communications:** Communication medium, Real time traffic, synchronous and asynchronous message, performance comparison, real time communication protocols.	6

	Total	36

Books:
1. Real Time Systems by Jane W. S. Liu, Pearson Education
2. Real Time Systems by C. M. Krishna and Kang G. Shin, McGrawHill Education
3. Real Time Systems: Theory and Practice, Rajib Mall, Pearson Education
4. Embedded Systems: Architecture, Programming and Design by Raj Kamal, Tata McGraw Hill Education

PARALLEL AND DISTRIBUTED SYSTEMS (IT 4223)

L-T-P = 3-0-0
Pre-requisites: Computer Organization & Architecture, Operating Systems, Computer Networks

Module #	Module Contents	#Lectures
1	Introduction to High Performance Computing: Distributed System models, Grid Computing, Cloud Computing, Cluster Computing, Super Computing, etc.	4
2	Computing Architectures, Flynn's and Handler's classifications, Multicore Processors, Scalable Multiprocessors	6
3	Distributed Systems and Middleware, Introduction to Sun RPC and JAVA RMI	4
4	Distributed storage and File systems.	4
5	Concurrency and Consistency models, Shared memory and Distributed memory.	6
6	Computing Clouds, Service-Oriented Architecture	6
7	Grid Computing Systems, Peer-to-peer computing and Overlay graphs	2
8	Load balancing.	4
9	Fault tolerance.	4
10	Security and Privacy	2
	Total	**42**

References:
1. Kai Hwang, Jack Dongarra and Geoffrey C. Fox. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet.
2. Andrew S. Tannenbaum and Maarten van Steen. Distributed Systems: Principles and Paradigms. Prentice Hall, 2nd Edition.
3. M. J. Quinn. Parallel Computing: Theory and Practice, McGraw Hill.

DEEP LEARNING (IT 4224)

L-T-P: 3 - 0 - 0

Prerequisite: Machine learning

Sl No.	Module and Topics name	# of Lectures
1	**Basics:** Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.	4
2	**Feedforward Networks:** Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.	3
3	**Deep Neural Networks:** Difficulty of training deep neural networks, Greedy layerwise training.	2
4	**Better Training of Neural Networks:** Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).	6
5	**Recurrent Neural Networks:** Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs	4
6	**Convolutional Neural Networks:** LeNet, AlexNet	4
7	**Generative models:** Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.	6
8	**Recent trends:** Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning	6
9	**Applications:** Vision, NLP, Speech	6
		40

Textbooks

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
2. Neural Networks: A Systematic Introduction, Raúl Rojas, 199
3. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

INTELLIGENT TRANSPORTATION AND SMART SYSTEMS (IT 4226)

L-T-P: 3-0-0

Sl. No.	Module Name and Topics	No. of Classes
1	Fundamentals of ITS: Overview and history of ITS from both public policy and market economic perspectives, Types of ITS, Historical Background, Benefits of ITS, Overview of ITS Applications.	3
2	Sensor Technologies and Data Requirements of ITS: Importance of telecommunications in the ITS. Information Management, Traffic Management Centers (TMC).Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centers; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.	10
3	ITS User Needs and Services and Functional Areas: Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS).	6
4	ITS Architecture: Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning.	6

5	ITS Applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	4
6	Economics of ITS: Congestion Pricing, Revenue Generation Models.	4
7	Security of ITS: Various security model to secure the ITS Systems	4
Total		**38**

Books:
1. Sussman, Joseph. Perspectives on Intelligent Transportation Systems (ITS). New York, NY: Springer, 2010.
2. Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003.
3. Fundamentals of intelligent transportation systems planning By Mashrur A. Chowdhury, Adel Wadid Sadek.
4. Lawrence A. Klein, Sensor technologies and Data requirements of ITS
5. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
6. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.
7. National ITS Architecture Documentation, US Department of Transportation, 2007.

MULTIMEDIA SYSTEMS (IT 4227)

L-T-P: 3-0-0

Module #	Module Name and Topics	# Lectures
1.	Introduction to Multimedia , Elements of Multimedia, Properties of multimedia system, Categories, Features, Application, Phases of multimedia application development, Multimedia development team, Convergence of Multimedia System.	2
2.	Image: Raster and Vector, Types of image, Digital image representation,	8

	Binary, Grayscale and color image, Image negation, change of dynamic range, Intensity level slicing, Histogram, Color model RGB, CMYK, HSB, HSV, CIE-lab, Conversion from one color model to other, File system (TIFF, BMP, PCX, GIF etc.), Display devices, CRT Monitor, LCD monitor, PDP, Touch screen- Resistive and capacitive, Surface acoustic wave, infrared touch screen, Flexible display-epaper and OLED. Digital Scanner, Digital Camera, Printer-dot matrix, inkjet, laser, 3D printer. Different research areas in image processing-OCR, Image encryption, Steganography	
3.	**Compression:** Advantages, disadvantages, Spatial and temporal redundancies, Different Lossless and Lossy compression techniques, Performance measurement, DPCM, Lampel-Ziv, Huffman coding, Adaptive Huffman coding, Arithmetic coding, GIF, JPEG.	6
4.	**Audio:** Sound wave, Physical characteristic, Musical note, Components of Audio System, Microphone:moving coil, condenser, Amplifier :class A Class B, Speaker, Synthesizer, MIDI. Sound card, Digital Audio processing.	4
5.	**Video:** Luminance & Chrominance, Luma and Chroma, Chroma Sub-sampling, Television Systems PAL, NTSC, Video Nomenclature HDTV, EDTV, Video Quality and Performance Measurements, Streaming video, DTH, IPTV, Digital Video Processing, Video capture, Video processing AVO/AVI file formats, Video compression- I, B, P frame, MPEG, Multimedia synchronization- skew and jitter.	6
6.	**Animation:** Key frame and Tweening, Cell Animation, Rotoscoping, Stop-Motion Animation, Motion Cycling, Computer Based Animation, Path based animation, Client pull and server push, Virtual reality	2
7	Multimedia Database-Image Representation, Segmentation, Similarity based retrieval, Image retrieval by color, Shape & texture, indexing – K-d-tree, R-tree, Video Content, Quad tree, Quarying, Video Segmentation, Indexing.	4
8	Multimedia Network Fundamentals, Multimedia Protocols for the Internet, Multimedia Networking Services	**4**
	Total:	**36**

References:
1) **R. Steinmetz**, K. **Nahrstedt**, "Multimedia Systems", Springer Science & Business Media.
2) J.F.K, Buford, Multimedia Systems, ACM Press.
3) Sloane, Multimedia Communication, McGraw Hill.

4) Boyle, Design for Multimedia Learning Prentice Hall.
5) B Prabhakaran, Kluwer, Multimedia Database Management Systems, Springer.

BIOINFORMATICS (IT 4226)

L-T-P: 3-0-0

Module #	Module Name and Topics	# Lectures
1	Sequence similarity, homology, and alignment. Pairwise alignment: scoring model,	6
2	dynamic programming algorithms, heuristic alignment, and pairwise alignment using Hidden Markov Models. Multiple alignment: scoring model,	9
3	local alignment gapped and ungapped global alignment. Motif finding: motif models, finding occurrence of known sites, discovering new sites. Gene Finding: predicting reading frames, maximal dependence decomposition.	12
4	Analysis of DNA microarray data using hierarchical clustering, model-based clustering, expectation-maximization clustering, Bayesian model selection.	9
	Total	36

Books:
1. Arthur M. Lesk, Introduction to bioinformatics, OUP, 2014
2. Mount, David W., and David W. Mount. *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor, NY: Cold spring harbor laboratory press, 2001.
3. Gregory R. Grant, Warren J. Ewens, Statistical Methods in Bioinformatics: An Introduction, Springer

COMPUTATIONAL GEOMETRY (IT 4261)

L-T-P: 3-0-0
Prerequisite(s): Concepts of Computer Graphics, Data Structures and Algorithms

Sl. No.	Module Name and Topics	#Lectures
1.	Computational Geometry: Introduction, degeneracy and robustness, Application domains	3
2.	Orthogonal range searching (in brief): kd-tree, range tree, Lower Bounds on Algebraic tree model and Geometric data structures (DCEL)	6

3.	The Maximal Points Problem (closest pair and farthest pair), Geometric searching, Slab method, Range searching	3
4.	Point Location and Triangulation, triangulating monotone polygon	4
5.	Convex Hull, Different Paradigms, Voronoi Diagram and Delaunay Triangulation, and Quickhull	6
6.	Line segment intersection, Linear programming, Intersection of convex polygons, planes	5
7.	Clustering Point Sets using Quadtrees and Applications	2
8.	Introduction using Basic Visibility Problems, visibility graph and edge and applications to robot path planning	3
9.	Shape Analysis and Shape Comparison	3
10	Intersection and union of rectangles and largest empty space recognition	2
11.	Some applications and case studies	3
	Total	40

References:
1. Computational Geometry Algorithms and Applications, Authors: de Berg, M., Cheong, O., van Kreveld, M., Overmars, M.
2. Computational Geometry, An Introduction, Authors: Preparata, Franco P., Shamos, Michae
3. Discrete and Computational Geometry, Satyan L. Devadoss & Joseph O'Rourke

DIGITAL SIGNAL PROCESSING (IT 4262)

L-T-P = 3-0-0
Pre-requisite(S): Signals, systems and circuits, Communication systems
Outcome: Students will learn about analysis of discrete time signals, Discrete Fourier Transform and digital filter design and quantization effect.

Module #	Course Coverage	#Lectures
1	**Discrete time Signals and Systems-** Time and Frequency domain representation	2
2	Discrete Signals: Z-Transforms, inverse z-Transform, properties of Z-transform	2

3	Difference equations and solution.	1
4	Linear time-invariant system, properties	2
5	Stability, Frequency Response; Linear phase systems.	1
6	**Realization of Digital Filters:** Recursive and non recursive structures. **IIR Filters-** Block Diagrams and signal flow graphs, direct cascade, parallel, ladder and lattice realizations	4
7	**Realization of Digital Filters: FIR Filters, Lattice structure. Quantization Effects**	4
8	**Digital Filter Design: IIR Filter-** Approximation theory, Impulse invariant and bilinear transformations, Frequency transformations.	2
9	**FIR Filter Design:** Windows and Frequency sampling techniques.	2
10	**Discrete Fourier Transforms-** Definitions, and properties, Circular convolution, Linear convolution.	4
11	**FFT Algorithms-** Basic DIT and DIF algorithms, Computational efficiency considerations.	4
12	**Finite Word Length Effects-** Quantization error and their effects on performance of digital signal processors	2
	Total	**32**

Books:

1. John G. Proakis (Author), Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4e, Pearson
2. A. H. Oppenheim, R. W. Schafer, "Digital Signal Processing", 2015, Pearson
3. Sanjit Mitra, "Digital Signal Processing", 4th ed.

INTERNET OF THINGS (IT 4263)

Prerequisite: The student may have concepts of embedded systems, wireless and computer networks, operating systems.

Sl. No.	Topics	Class hours
1	Introduction to the internet of things	3
2	Basic of Internet technologies	6
3	IoT standards, open-source vs closed source	6

4	Introduction of embedded computing	4
5	IP as the IoT network layer	4
6	Getting started with API	4
7	Data and analytics for IoT	6
8	IoT Data security	6
	Total	39

Books:
1. Designing the Internet of Things By Adrian McEwen, Hakim Cassimally, J Wiley
2. Precision - Principles, Practices, and Solutions for the Internet of Things, Book by Timothy C K Chou, McGraw-Hill
3. Getting Started with the Internet of Things, Cuno Pfister, O Reilly media
4. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Cisco Press

MULTIMEDIA SYSTEMS (IT 4264)

L-T-P: 3-0-0

Module #	Module Name and Topics	# Lectures
2.	Introduction to Multimedia , Elements of Multimedia, Properties of multimedia system, Categories, Features, Application, Phases of multimedia application development, Multimedia development team, Convergence of Multimedia System.	2
6.	Image: Raster and Vector, Types of image, Digital image representation, Binary, Grayscale and color image, Image negation, change of dynamic range, Intensity level slicing, Histogram, Color model RGB, CMYK, HSB, HSV, CIE-lab, Conversion from one color model to other, File system (TIFF, BMP, PCX, GIF etc.), Display devices, CRT Monitor, LCD monitor, PDP, Touch screen- Resistive and capacitive, Surface acoustic wave, infrared touch screen, Flexible display-epaper and OLED. Digital Scanner, Digital Camera, Printer-dot matrix, inkjet, laser, 3D printer. Different research areas in image processing-OCR, Image encryption,	8

	Steganography	
7.	Compression: Advantages, disadvantages, Spatial and temporal redundancies, Different Lossless and Lossy compression techniques, Performance measurement, DPCM, Lampel-Ziv, Huffman coding, Adaptive Huffman coding, Arithmetic coding, GIF, JPEG.	6
8.	Audio: Sound wave, Physical characteristic, Musical note, Components of Audio System, Microphone:moving coil, condenser, Amplifier :class A Class B, Speaker, Synthesizer, MIDI. Sound card, Digital Audio processing.	4
9.	Video: Luminance & Chrominance, Luma and Chroma, Chroma Sub-sampling, Television Systems PAL, NTSC, Video Nomenclature HDTV, EDTV, Video Quality and Performance Measurements, Streaming video, DTH, IPTV, Digital Video Processing, Video capture, Video processing AVO/AVI file formats, Video compression-I, B, P frame, MPEG, Multimedia synchronization- skew and jitter.	6
6.	Animation: Key frame and Tweening, Cell Animation, Rotoscoping, Stop-Motion Animation, Motion Cycling, Computer Based Animation, Path based animation, Client pull and server push, Virtual reality	2
7	Multimedia Database-Image Representation, Segmentation, Similarity based retrieval, Image retrieval by color, Shape & texture, indexing –K-d-tree, R-tree, Video Content, Quad tree, Quarying, Video Segmentation, Indexing.	4
8	Multimedia Network Fundamentals, Multimedia Protocols for the Internet, Multimedia Networking Services	**4**
	Total:	**36**

References:
6) **R. Steinmetz**, K. **Nahrstedt**, "Multimedia Systems", Springer Science & Business Media.
7) J.F.K, Buford, Multimedia Systems, ACM Press.
8) Sloane, Multimedia Communication, McGraw Hill.
9) Boyle, Design for Multimedia Learning Prentice Hall.
10) B Prabhakaran, Kluwer, Multimedia Database Management Systems, Springer.

CAD FOR VLSI (IT 4265)

L-T-P: 3-0-0
Prerequisites: Introductory course on Digital Logic and Computer Organization..

Module #	Module Name and Details	# Lectures
1	Introduction: VLSI design flow, challenges.	2
2	Verilog/VHDL: Introduction and use in synthesis, modeling combinational and sequential logic, writing test benches.	6
3	Logic synthesis: two-level and multilevel gate-level optimization tools, state assignment of finite state machines.	4
4	Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding, Technology mapping.	4
5	Physical design automation: Review of MOS/CMOS fabrication technology, VLSI design styles: full-custom, standard-cell, gate-array and FPGA.	4
6	Physical design automation algorithms: Floor-planning, placement, routing, compaction, design rule check, power and delay estimation, clock and power routing, etc. Special considerations for analog and mixed-signal design.	8
7	Testability issues: Fault modelling and simulation, test generation, design for testability, built-in self-test. Testing SoCs.	8
8	Basic concepts of verification: Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification, Formal verification, Basics of equivalence checking and model checking. Hardware emulation.	4
	Total	**40**

Text Books:
1. M.D.Ciletti, "Modeling, Synthesis and Rapid Prototyping with the Verilog HDL", Prentice-Hall.
2. M.G.Arnold, "Verilog Digital – Computer Design", Prentice-Hall.
3. VLSI Physical Design Automation Theory and Practice – by Sait, Youssef, World Scientific.
4. Algorithms for VLSI Physical Design Automation by Naveed Shervani, Springer International Edition, 3rd Edition, 2005.
5. G. De Micheli. Synthesis and optimization of digital circuits, 1st edition, 1994
6. Gary D. Hachtel and Fabio Somenzi, Logic Synthesis and Verification Algorithms. Springer.

Reference Books:
1. Digital Integrated Circuits- A Design Perspective by J M Rabaey, Prentice Hall, 3rd Edition, 2012.
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.
3. Douglas L. Perry, VHDL: Programming by Example 4th Edition, TMH.
4. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip

and System Design, Springer, 1st edition, 1992.
5. Rudiger E bendt, Görschwin Fey, Rolf Drechsler. Advanced BDD Optimization.

COGNITIVE RADIO NETWORKS (IT 4266)

L-T-P: 3-0-0

Prerequisite: The students expect to have basic knowledge on Wireless Communications/ Wireless networks, Communication Engg.

Module #	Module Contents	# Lectures
1	**Next generation/5G wireless networks**: Introduction to cognitive radio networks, spectrum scarcity problem, network architectures, Cognitive cycle and functional components	2
2	**Spectrum sensing (SS) in CRN,** Different SS techniques,- energy detection, Matched filter detection, , feature detection, Cyclo-stationary feature detection, likelihood ration test (LRT), GLRT techniques **Cooperative SS-** soft and hard decision fusion, Energy Efficient CSS, security threats in CSS.	8
3	**Joint SS and Data Transmission**,-Link layer design and common control channel, resource allocation-power allocation and channel assignment, optimized system design	4
4	**Multi-hop CRN**: Routing protocols, both centralized, and distributed geographic forwarding and probabilistic approaches-outage analysis	4
5	**Network Protocol Design for CR:** Transport layer protocol design, both TCP- and equation-based Standards and applications	2
6	**Security threats in CRN**: Security threats in SS- PUEA and SSDF arracks. Eavesdropping and secrecy outage in CRN, Jamming for eavesdropping protection, jammer selection, ergodic capacity analysis	6
7	**Energy Harvesting in CRN**-Wireless energy transfer and scavenging, SWIPT concept, linear and non-liner modeling of EH, Circuit design and interfacing RF energy harvesting boards	6
8	**Machine Learning in CRN**: Spectrum Prediction and spectrum database formation, Q-routing	4

9	**Application Specific System Design in CRN**- Wireless Medical Telemetry Services (WMTS), cognitive radio vehicular networks (CR-VANET), CR for emergency communication, CR-IoT, D2D cooperative CRN, CRN for smart city	6
	Total	**42**

References:

1) Principles of Cognitive Radio

Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein, H. Vincent Poor, Narayan B. Mandayam

Cambridge University Press, 2013 - Computers

2) Handbook of Cognitive Radio

Editors: Zhang, Wei (Ed.) Springer

3) Cognitive Wireless Communication Networks

Editors: Hossain, Ekram, Bhargava, Vijay K. (Eds.) Springer

MOBILE COMPUTING (IT 4267)

L-T-P: 3-0-0

Prerequisites: The students opting for this subject must have prior knowledge in Networking, Operating systems, and basic communication.

Lec no.	Topic	# Lectures
1.	Introduction to mobile computing	2
2.	Wireless and Cellular network, channel allocation, multiple access	2
3.	1G, 2G, systems, GSM standards, architecture	4
4.	Location management, Handoffs, Authentication	2
5.	2G CDMA, 3G CDMA, 4G standards and advances	4
6.	IEEE 802.11 WLAN	4
7.	Bluetooth, HiperLAN architecture, comparison of wireless technologies	4
8.	Mobility adaptation, process migration, mobile IP	4
9.	Mobile Ad-hoc networking. MAC protocols, Routing	4

10.	Security, Energy-efficient computing, Impact of mobility on algorithms	4
Total		34

Books:

1. Fundamentals of Mobile Computing by Pattnaik Mall, PHI
2. Mobile Computing, by Talukder Asoke K. Mcgraw Hill
3. Mobile Computing Third Edition, by RAJ KAMAL, Oxford University Press
4. Mobile Communications, by Jochen Schiller, Second Edition, Pearson Education, 2003.