

## **Information and Communication Technology (ICT)**

### **Vision:**

To be a recognized leader by imparting quality technical education and thereby facilitating the extensive research environment, equipping students with latest skills in the field of technology supplemented with practical orientation to face challenges in the fast morphing modern computing industry and academic for the betterment of the society.

### **Mission:**

- To produce best quality Information Technology professional and researchers by providing state of the art training, hands on experience and healthy research environment.
- To collaborate with industry and academic around the globe for achieving quality technical education and excellence in research through active participation of all the stakeholders.
- To promote academic growth by offering inter-disciplinary postgraduate and doctoral programs.
- To establish and maintain an effective operational environment and deliver quality, prompt, cost effective and reliable technology services to the society as well as compliment the local and global economic goals.

### **Programme Educational Objectives (PEOs)**

The educational objectives of department of Information Technolgy of VSSUT, Burla are to prepare its graduates:

PEO1: To motivate students for application of learned concepts leading to research and innovation.

PEO2: To prepare students capable of designing and developing real-world computing applications.

PEO3: To provide students with academic and research environment that enables them to innovate based on the requirement of the society.

	M1	M2	M3	M4
PEO-1	3	3	2	2
PEO-2	3	2	1	3
PEO-3	3	2	2	3

**Programme Outcomes:**

On completion of the M.Tech (ICT) programme, the students shall have:-

PO1	An ability to independently carry out research/investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to identify, analyze, design, implement and integrate software and hardware-based computer systems.
PO5	An ability to effectively manage projects involving multidisciplinary and teams with ethnic diversity.
PO6	An ability to relate the knowledge of mathematical foundations, scientific principles and information and communication technologies to model and design solutions for real time problems in the domain of ICT.

**Programme Specific Outcomes:**

PSO1: To analyze software products, procedures in a methodical way by applying problem solving skills, employable in product-oriented industry.

PSO2: To gain the ability to pursue higher studies, Research & Development and entrepreneurships in the modern computing environment.

**Course Structure**  
**For**  
**PG Programme to be introduced from July 2019**  
**Specialization: M.Tech, Information & Communication Technology (ICT)**

**Semester I**

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1		Advance Computer Networks	3	0	0	3
2	Core-2		Internet & Web Technology	3	0	0	3
3	PE-1		Service Oriented Architecture	3	0	0	3
			Advance Operating Systems				
			Cryptographic Foundation				
			Internet of Things				
4	PE-2		Embedded System Design	3	0	0	3
			Fault- Tolerant Systems				
			Big Data Analysis				
			Evolutionary Computing				
5	Common		Research Methodology & IPR	3	0	0	3
6	Lab-1		Computing Lab-I	0	0	3	2
7	Lab-2		Computing Lab-II	0	0	3	2
8	Audit -1						
<b>Total Credits</b>							19

**Semester II**

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3		Computational Intelligence	3	0	0	3
2	Core-4		Advance Software Engineering	3	0	0	3
3	PE-3		Wireless Networks & Mobile Computing	3	0	0	3
			Image and Video Processing				
			Network Security				
			Cloud Architecture				
4	PE-4		Advanced Computer Architecture	3	0	0	3
			Deep Learning				
			Intrusion Detection Systems				
			Intellectual Property Rights				
			Real Time System Design				
	Parallel Processing						
5	Common		Minor project & Seminar	0	0	4	2
6	Lab-3		Computing Lab-III	0	0	3	2
7	Lab-4		Computing Lab-IV	0	0	3	2
8	Audit -2						
<b>Total Credits</b>							18

**Semester III**

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-5		Pattern Recognition	3	0	0	3
			E-Commerce & ERP				
			Bio-informatics				
			Information Theory & Coding				
			VLSI Design				
2	OE-1			3	0	0	3
3	Minor Project		Dissertation (Phase-I)	0	0	20	10
<b>Total Credits</b>							16

**Semester IV**

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Major Project		Dissertation (Phase-II)	0	0	32	16
<b>Total Credits</b>							16

**GRAND TOTAL CREDITS: 19+18+16+16= 69**

**Audit course 1 & 2**

1. English for Research Paper Writing

2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

**List of Open Electives**

<b>Sl. No.</b>		<b>Subject Name</b>
<b>1</b>	<b>OE-I</b>	<b>Information Theory &amp; Coding</b>
<b>2</b>		<b>Computational Intelligence</b>
<b>3</b>		<b>Advance Software Engineering</b>
<b>4</b>		<b>Internet &amp; Web Technology</b>
<b>5</b>		<b>Advance Computer Networks</b>

# **1<sup>st</sup> SEMESTER**

**ADVANCED COMPUTER NETWORK**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(08 Lectures)**

Introduction: Building of a Computer networks, classifications of computer networks, Protocol Layers and Their Service Models, The Internet Protocol Stack, Network performance (BW, delay x BW, RTT), Internet Backbones, NAPs and ISPs

**Module-II**

**(08 Lectures)**

Network Layer and Routing: Introduction and Network Service Models, Routing Principles, Hierarchical Routing, Internet Protocol, IP Fragmentation, Routing in the Internet, inside a router, IPv6, Multicast Routing

**Module-III**

**(08 Lectures)**

Link Layer and Local Area Networks: The Data Link Layer: Introduction, Services, Error Detection and Correction, Multiple Access Protocols and LANs, LAN Addresses and ARP, Ethernet, CSMA/CD Applet, Hubs, Bridges and Switches, Wireless LANs: IEEE 802.11, The Point-to-Point Protocol, ATM, X.25 and Frame Relay

**Module-IV**

**(08 Lectures)**

**Multimedia Networking:** Multimedia Networking Applications, Streaming Stored Audio and Video, Making the Best of the Best-Effort Service: An Internet Phone Example, RTP, Scheduling and Policing Mechanisms for Providing QoS Guarantees, Integrated Services.

**Module-V**

**(08 Lectures)**

**Network Management:** What is Network Management?, The Infrastructure for Network Management, The Internet Network Management Framework, ASN.1, Firewalls

Text Book:

1. Computer Networking: A Top-Down Approach, 6th Edition, Kurose & Ross, 2013, Pearson

References:

1. A. Tannenbaum: Computer Networks, 3rd ed., Prentice Hall India, 1996.
2. W. Stallings: ISDN and Broadband ISDN With Frame Relay and ATM, Prentice Hall, Englewood Cliffs, 1995.
3. W. Stallings: Local and Metropolitan Area Networks, 4th ed., Macmillan, New York, 1993.
4. L. L. Paterson and B. S. Davie: Computer Network, Morgan Kaufman, San Mateo, 2000.

**Course Outcomes:**

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After completing this course the students should be able to:

1. Define and memorize various components required to the design of computer networks
2. Conceptualize and understand the Layered Architecture of Computer Networks.
3. Use appropriate network tools to build network topologies.
4. Analyse existing network protocols and networks.
5. Evaluate the performance of computer networks by employing various network protocols and algorithms

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	-	3	3	-	3
<b>CO2</b>	3	-	3	3	-	3
<b>CO3</b>	3	-	3	3	-	3
<b>CO4</b>	3	-	3	3	-	3
<b>CO5</b>	3	-	3	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	-	3	3	-	3

**INTERNET AND WEB TECHNOLOGY**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I (08 Lectures)**

**Internet Architecture:** Internet overview, evolution of internet. Internet components: Local Area Networks, Access Networks, Core Networks, Routers, Transmission infrastructure, ISPs. TCP/IP model, TCP/IP vs OSI model. **HTML:** HTML Overview, Structure of HTML Documents, Document Types, HTML Elements and attributes. Anchor Attributes, Image Tag and its attributes, Image and Anchors, Table.

**Module-II (08 Lectures)**

**Image Map:** Attributes, Client-Side Image Maps and Server Side Maps.  
**HTML Layout:** Background, colors and text, Tables, Frames, Layers, Page content Division <Div>, <SPAN>. **CSS:** Style Sheet Basic, Properties, Positioning with Style Sheet.  
**Forms:**<FORM> Elements, Form controls. Dynamic HTML.

**Module-III (08 Lectures)**

**Java Script:** Introduction, Client-Side JavaScript, Server-Side JavaScript, JavaScript Objects, JavaScript Security. **Operators:** Assignment Operators, Comparison Operators, Arithmetic Operators, Increment, Decrement, Unary Negation, Logical Operators, String Operators, Special Operators, Conditional operator, Comma operator, delete, new, this, void.  
**Statements:** Break, comment, continue, delete, do ... while, export, for, for...in, function, if...else, import, labelled, return, switch, var, while.

**Module-IV**

**(08 Lectures)**

JavaScript (Properties and Methods of Each):Array, Boolean, Date, Function, Math, Number, Object, String, RegExp. Document and its associated objects, document, Link, Area, Anchor, Image, Applet, Layer.

**Events and Event Handlers:** General Information about Events, Defining Event Handlers, event.

**Module-V**

**(08 Lectures)**

**Server-Side Programming:**Introduction to Common Gateway Interface (CGI), Active Server Pages and PHP for accessing database.

**Internet applications:** FTP, Telnet, Email, Chat. **World Wide Web:** HTTP protocol. Search Engines. E-commerce, Internet telephony, and virtual reality over the web, etc. Intranet and extranet, firewall.

**Textbooks:**

1. Computer Networking: A Top-Down Approach Featuring the Internet by Kurose and Ross.
2. Web Design the Complete Reference by Thomas Powell, Tata McGrawHill.

**Reference Books:**

1. HTML The Complete Reference by Thomas Powell, Tata McGrawHill.
2. JavaScript the Complete Reference, Second Edition by Thomas Powell, Fritz Schneider. Tata McGrawHill.

**Course Outcome:**

1. Analyse internet architecture.
2. Implement HTML web page using basic HTML tags, CSS, forms, dynamic HTML.
3. Implement dynamic HTML using JavaScript Language to perform functionalities at client side.
4. Develop graphical user interface applications for user interaction.
5. Organise and implement web server for the management and delivery of information.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	2	2
CO2	2	-	-	3	2	2
CO3	2	-	-	3	2	2
CO4	2	-	-	3	2	2
CO5	2	-	-	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	-	3	2	2

## Service Oriented Architecture

**L-T-P: 3-0-0**

**Cr.-3**

**Module I**

**Introduction To Xml :** XML document structure – Well-formed and valid documents, Namespaces, DTD, XML Schema, X-Files.

**Module II**

**Building Xml- Based Applications:** Parsing XML – using DOM, SAX, XML Transformation and XSL, XSL Formatting, Modeling Databases in XML.

**Module III**

**Service Oriented Architecture:** Characteristics of SOA, Comparing SOA with Client-Server and Distributed architectures. Benefits of SOA -- Principles of Service orientation, Service layers.

**Module IV**

**Web Services:** Service descriptions, WSDL, Messaging with SOAP, Service discovery, UDDI, Message Exchange Patterns, Orchestration, Choreography, WS Transactions.

**Module V**

**Building Soa-Based Applications:** Service Oriented Analysis and Design, Service Modeling, Design standards and guidelines. Composition – WS-BPEL , WS-Coordination , WS-Policy, WS-Security , SOA support in J2EE.

**Text Books:**

1. Ron Schmelzer et al. “*XML and Web Services*”, Pearson Education,2002.
2. Thomas Erl, “*Service Oriented Architecture: Concepts, Technology, and Design*”, Pearson Education, 2005.

**References**

1. Frank P.Coyle, “XML, Web Services and the Data Revolution”, Pearson Education,2002.
2. Eric Newcomer, Greg Lomow, “Understanding SOA with Web Services”, Pearson Education,2005.
3. Sandeep Chatterjee and James Webber, “Developing Enterprise Web Services: An Architect's Guide”, Prentice Hall,2005.
4. James McGovern, Sameer Tyagi, Michael E.Stevens, Sunil Mathew, “Java Web Services Architecture”, Morgan Kaufmann Publishers,2003.

### Course Outcomes

1. Analyse the XML Schema, Name Space and Document Structure.
2. Develop applications based on XML.
3. Evaluate the SOA Principles and Service Layers.
4. Construct Web service using technology elements.
5. Develop SOA based applications for intra and inter enterprise applications. Resolve the security issues in XML.

### Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	3	2	3
CO2	2	-	-	3	2	3
CO3	2	-	-	3	2	3
CO4	2	-	-	3	2	3
CO5	2	-	-	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

### Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	-	3	2	3

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I:**

**(08 Lectures)**

**Fundamentals:** What is a Distributed computing system , Evolution of Distributed Computing Systems, Distributed Computing Systems models, What are Distributed Computing Systems Gaining Popularity, Issues in Designing a Distributed Operating System, Introduction to distributed Computing Environment (DCE) .

**Message Passing :** Introduction, Desirable Features of Good Message-Passing System, Issues in IPC by Message Passing, Synchronization, Buffering, Multidatagram Messages, Encoding and Decoding of Message Data, Process Addressing , Failure Handling , Group communication.

**Module-II:**

**(08 Lectures)**

**Remote Procedure Calls:-** Introduction, The RPC Model, Transparency of RPC, Implementing RPC Mechanism, Stub Generation, RPC Messages Marshaling Arguments and Results, Server Management, Parameter-Passing Semantics , Call Semantics, Communication protocols for RPCs. Complicated RPCs, Client-Server Binding, Exception handling, Security, Some Special types of RPCs, RPC in Heterogeneous Environments, Lightweight RPC.

**Module-III:**

**(08 Lectures)**

**Distributed Shared Memory:** Introduction, General Architecture of DSM Systems, Design and Implementation issues of DSM, Granularity, Structure of Shared Memory Space, Consistency Models, Replacement Strategy, Thrashing , Other Approaches to DSM, Heterogeneous DSM. Advantages of DSM.

**Module-IV:**

**(08 Lectures)**

**Synchronization:** Introduction, Clock Synchronization , Event ordering, Mutual Exclusion, Deadlock, Election Algorithms.

**Resources Management :** Introduction , Desirable Features of a Good Global Scheduling Algorithm, Task Assignment Approach, Load Balancing Approach, Load sharing Approach

**Process Management:** Introduction, Process Migration, Threads

**Module-V:**

**(08 Lectures)**

**Distributed file Systems:** Introduction, Desirable Features of a good Distributed file Systems, File Models, File Accessing Models, File-Sharing Semantics, File-Caching Schemes, File Replication, fault Tolerance, Atomic Transactions, Design principles, Naming:Introduction, Desirable Features of a Good Naming Systems, Fundamentals Terminologies and Concepts, System-Oriented Names, Object-Locating Mechanisms, Human-Oriented Names, Name Caches, Naming and Security.

**Security:** Introduction, Potential Attacks to Computer Systems, Cryptography, Authentication, Access control, Digital Signatures, Design principles.

**Text Books:**

1. Distributed Operating System – Concept & Design, by – P.K.Sinha, PHI

**Reference Books:**

1. Operating System Concepts & Design, Milan Milenkovic, TMH.
2. Operating System, H.M.Beitel, Pearsons.

**Course Outcomes:**

At the end of this course, students will be able to :

- CO1:** Investigate the structure and concepts, various design issues like transparency, flexibility etc in distributed operating systems.
- CO2:** Demonstrate important theoretical foundations including Process communication, Synchronization, Concurrency, Event ordering, Mutual Exclusion, Deadlock, Agreement Protocol, Security, Recovery and fault tolerance and Provide comprehensive coverage of the major developments in distributed Operating System
- CO3:** Analyze important theoretical foundations including Process Synchronization, Concurrency, and Event ordering, Mutual Exclusion, Deadlock, Agreement Protocol, Security, Recovery and fault tolerance.
- CO4:** Evaluate the major developments in distributed Operating System, Multi-processor scheduling, real time scheduling and designing of distributed file systems.
- CO5:** Implement and Formulate the solutions to various algorithms required for resource management, scheduling, allocation and communication, file sharing mechanism in distributed Applications in preparation to entering the industry or in pursuit of postgraduate studies.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
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<b>CO1</b>	3	1	2	2	3	2
<b>CO2</b>	3	1	2	2	3	2
<b>CO3</b>	3	1	2	2	3	2
<b>CO4</b>	3	1	2	2	3	2
<b>CO5</b>	3	1	2	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	1	2	2	3	2

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(08 Lectures)**

Introduction to Security: Definition, Goal and Challenges, OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, Techniques, Model for Network Security,

**Module-II**

**(08 Lectures)**

Mathematics of Cryptography: Integer Arithmetic, Modular arithmetic, Matrices, Linear Congruence, Algebraic Structures: Group, Ring, Field, Galois Field, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Stream and Block Cipher, Steganography.

**Module-III**

**(08 Lectures)**

Modern Symmetric Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers, Data Encryption Standard (DES): DES Structure, DES Analysis, Multiple DES, Security of DES, Advanced Encryption Standard (AES), AES Transformation functions, Analysis of AES, Use of Modern Block Ciphers: ECB, CBC, CFB, OFB, CTR, Use of Stream Ciphers: RC4, Key Management, Key Generation.

**Module-IV**

**(08 Lectures)**

Number Theory: Prime Numbers, Fermat's and Euler's Theorems, Testing of Primality, Shinese Remainder Theorem, Exponentiation and Logarithm, RSA Algorithm, Elgamal Cryptosystem, Elliptic Curve Cryptography, Diffe-Hellman Key Exchange.

**Module-V**

**(08 Lectures)**

Message Authentication Codes (MACs): Formal Definition of Weak and Strong MACs, using a PRF as a MAC, Variable length MAC, Public Key Signature Schemes: Formal Definitions, Signing and Verification, Formal Proofs of Security of Full Domain Hashing, Assumptions for Public Key Signature Schemes: One way functions Imply Secure One-time Signatures, Shamir's Secret Sharing Scheme, Formally Analyzing Cryptographic Protocols

**Text Book:**

1. B. A. Forouzan, *Cryptography & Network Security*, McGraw Hill, Special Indian Edition, 2007.
2. W. Stallings, *Cryptography and Network Security*, Pearson Education, 3rd Ed, 2006.

**References:**

1. R. E. Smith, *Internet Cryptography*, AWL.
2. A. J. Menezes, *Handbook of Applied Cryptography*, CRC Press.
3. J. Hershey, *Cryptography Demystified*, McGraw Hill.
4. J. Knudsen, *Java Cryptography*, O'Reilly.

**Course Outcomes:**

At the end of this course students will be able to:

1. Express principles of security and security services.
2. Identify security threats and determine efforts to counter them
3. Apply knowledge of computing and mathematics for developing efficient security algorithms.
4. Write code for relevant cryptographic algorithms.
5. Relate cryptographic primitives and their implementations for correctness, efficiency, and security.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	3
CO2	3	-	3	3	-	3
CO3	3	-	3	3	-	3
CO4	3	-	3	3	-	3
CO5	3	-	3	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	3	3	-	3

**INTERNET OF THINGS**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(8Lectures)**

Introduction to Internet of Things Introduction-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies- Wireless Sensor Networks , Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IoT Levels & Deployment Templates.

**Module-II**

**(8Lectures)**

Domain Specific IoTs. Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response, Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection, Energy- Smart Grids, Renewable Energy Systems, Prognostics, Retail-Inventory Management, Smart Payments, Smart Vending Machines, Logistics-Route Generation & Scheduling , Fleet Tracking , Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture-Smart Irrigation,Green House Control,Industry -Machine Diagnosis & Prognosis. Indoor Air Quality Monitoring,Health & Lifestyle -Health & Fitness Monitoring.

**Module-III**

**(8Lectures)**

Wearable Electronics IoT and M2M Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization

**Module-IV**

**(8Lectures)**

IoT Platforms Design Methodology IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device & Component Integration, Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT Physical Devices & Endpoints.

**Module-V**

**(8 Lectures)**

IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- pcDuino, Beagle Bone Black , Cubieboard.

**Text Books:** Internet of Things, A Hands-on Approach, by ArshdeepBahga& Vijay audisetti, University Press.

**Reference Books:** The Internet of Things, by Michael Millen, Pearson

**Course Outcome:**

At the end of this course students will be able to:

1. Express usage of Internet of Things in different contexts.
2. Define the technology and standards relating to IoTs
3. Differentiate between the layers of IoT stack and protocols used in each layer.
4. Incorporate the IoT concepts with broader ICT industry and possible future trends
5. Apply the knowledge and skills acquired to build and test a complete working IoT system involving prototyping, programming and data analysis.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	3
CO2	3	-	3	3	-	3
CO3	3	-	3	3	-	3
CO4	3	-	3	3	-	3
CO5	3	-	3	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	3	3	-	3

**EMBEDDED SYSTEMS DESIGN**

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**L-T-P: 3-0-0**

**Cr.-3**

**Module – I**

**(12 Lectures)**

Introduction: Features of Embedded systems, Design matrices, Embedded system design flow.

ARM: An advanced Micro Controller, Brief history, ARM pipeline, Instruction Set Architecture (ISA): Registers, ARM Instructions, THUMB, FPGA.

**Module – II**

**(06 Lectures)**

Interfacing: Devices and device drivers, Serial peripheral interfaces (SPI), Inter Integrated Circuit (IIC), RS232C, RS422, RS485, USB, Infrared communication (IrDA), Bluetooth.

**Module – III**

**(10 Lectures)**

Real time operating system: Hard real time, Firm real time, Soft real time, Task periodicity: Periodic task, Sporadic task, Aperiodic task, Task scheduling, Scheduling algorithms: Clock driven scheduling, Event driven scheduling, Commercial Real-time operating systems.

**Module – IV**

**(06 Lectures)**

Hardware and software partitioning: K-L partitioning, Partitioning using Genetic Algorithm, Particle Swarm Optimization, Hardware software co-simulations.

**Module – V**

**(06 Lectures)**

Low power embedded system design: Dynamic power dissipation, Static power dissipation, Power reduction techniques, system level power management.

**Text Books:**

1. “Embedded System Design” S. Chattopadhyay, PHI.
2. “Embedded system architecture, programming and design” Raj Kamal, TMH.

**Reference Books:**

1. “Hardware software co-design of Embedded systems” Ralf Niemann, Kulwer Academic.
2. “Embedded real time system programming” Sriram V Iyer, Pankaj Gupta, TMH.
3. “Real-Time Systems-Theory and practice” Rajib Mall, Pearson Education
4. “Embedded System Design” Peter Marwedel, Springer
5. “Designing Embedded Hardware” John Catsoulis, O’Reilly

**Course Outcomes:**

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After completing this course, the students should be able to:

1. Define and memorize about embedded system design flow and ARM architecture.
2. Incorporate different Interfacing devices for embedded system design.
3. Apply the concept of various scheduling algorithms for Real Time Operating for efficient embedded system design.
4. Analyze, compare and differentiate efficient Hardware Software partitioning algorithm for a particular embedded system design.
5. Design various low power devices for embedded system.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	-
CO2	3	-	3	-	-	-
CO3	3	-	3	2	3	-
CO4	3	-	3	3	3	-
CO5	3	-	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	3	1	2	-

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I – INTRODUCTION**

**(08 Lectures)**

Definition of fault tolerance, Redundancy, Applications of fault-tolerance, Fundamentals of dependability. Reliability, availability & safety.

**Module-II – IMPAIRMENTS**

**(08 Lectures)**

Faults, errors and failures, Means: fault prevention, removal and forecasting

**Module-III - DEPENDABILITY EVALUATION**

**(08 Lectures)**

Common measures: failures rate, mean time to failure, mean time to repair, etc. Reliability. Block diagrams, Markov processes.

**Module-IV - REDUNDANCY**

**(08 Lectures)**

Hardware redundancy, Redundancy schemes, Evaluation and comparison, Applications, Information redundancy, Codes: linear, Hamming, cyclic, unordered, arithmetic, etc., Encoding and decoding techniques, Applications, Time redundancy

**Module-V- PROGRAMMING**

**(08 Lectures)**

Software fault tolerance, Specific features, Software fault tolerance techniques: N-version, programming, recovery blocks, self-checking software, etc.

**Text Books**

- 1 Anderson, T., and P.A. Lee, Fault-Tolerant Principles and Practices, Prentice-Hall
- 2 Hwang, K., and F.A. Briggs, Computer Architecture and Parallel Processing, McGraw-Hill. Jalote, P.
3. Fault-Tolerance in Distributed Systems, ISBN 0-13-301367-7, Prentice-Hall,

**Reference Book**

1. Johnson, B.W., Design and Analysis of Fault-Tolerant Systems, Addison Wesley
2. Leveson, Nancy G., Safeware, system safety and computers, Addison Wesley.
3. Pradhan, D.K., Fault-Tolerant Computing — Theory and Techniques, (2 Volumes), Prentice-Hall.
4. Pradhan, Dhiraj K., Fault-Tolerant Computer System Design, ISBN 0-13-057887-8, Prentice-Hall

**Course Outcomes:**

At the end of the course students should be able:

1. To analyze different types of redundancy and its application for the design of computer systems being able to function correctly even under presence of faults and data errors.
2. To analyze different types of Terminology and definitions, Design techniques for fault-tolerance, Analysis of fault-tolerant system, Project management and development processes, System examples.
3. To analyze how fault-tolerant systems are used in applications that require high dependability, such as safety-critical control systems in vehicles and airplanes, or business-critical systems for e-commerce, automatic teller machines and financial transactions.
4. To plan how to calculate reliability of a system. Use of tools for reliability modelling
5. To analyze the various methods for SW fault tolerance. NVP, recovery blocks, run-time checks, problem of predicate detection.

**Course Articulation Matrix**

	PO01	PO02	PO03	PO04	PO05	PO06
CO01	3	3	3	3	3	3
CO02	3	3	3	3	2	2
CO03	3	3	3	3	2	1
CO04	3	3	2	2	1	2
CO05	3	3	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO01	PO02	PO03	PO04	PO05	PO06
COURSE	3	3	3	3	1	2

## BIG DATA ANALYSIS

**L-T-P: 3-0-0**

**Cr.-3**

### **Module-I: INTRODUCTION TO BIG DATA AND HADOOP**

**(08 Lectures)**

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to InfosphereBigInsights and Big Sheets.

### **Module-II : HDFS(Hadoop Distributed File System)**

**(08 Lectures)**

The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

### **Module-III: Map Reduce**

**(08 Lectures)**

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

### **Module-IV: Hadoop Eco System**

**(08 Lectures)**

**Pig: Introduction** to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

**Hive:** Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions.

**Hbase :**HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

**Big SQL:** Introduction

### **Module-V: Data Analytics with R Machine Learning:**

**(08 Lectures)**

Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR

### **Text Books**

- Tom White “Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
- Seema Acharya, SubhasiniChellappan, "Big Data Analytics" Wiley 2015.

## References

- Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
- Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
- Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press.
- AnandRajaraman and Jeffrey David Ulman, "Mining of Massive Datasets", Cambridge University Press, 2012.
- Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
- Glen J. Myat, "Making Sense of Data", John Wiley & Sons, 2007
- Pete Warden, "Big Data Glossary", O'Reily, 2011.
- Michael Mineli, Michele Chambers, AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.
- ArvindSathi, "BigDataAnalytics: Disruptive Technologies for Changing the Game", MC Press, 2012
- Paul Zikopoulos ,DirkDeRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles , David Corigan , "Harness the Power of Big Data The IBM Big Data Platform ", Tata McGraw Hill Publications, 2012.

## COURSE OUTCOME :

CO1-Define the Big Data Platform and its Use cases

CO2-Write overview of Apache Hadoop

CO3-Analyze HDFS Concepts and Interfacing with HDFS

CO4-Demonstrate Map Reduce Jobs

CO5- Incorporate analytics on Structured, Unstructured Data.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	-	2	-	-	-
<b>CO2</b>	-	2	-	3	-	1
<b>CO3</b>	2	-	2	3	3	3
<b>CO4</b>	-	-	3	3	3	3
<b>CO5</b>	3	-	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	2	3	3	3	3

**EVOLUTIONARY COMPUTING**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(10 Lectures)**

Genetic Algorithm: Basic concepts, Search space, working principle. Encoding: binary, Octal, Hexadecimal, permutation, Value and Tree. Decoding, fitness function, Selection: Roulette-wheel, Boltzmann, Tournament, Rank and Steady-state. Elitism, Crossover: single-point, two-point, multi-point, uniform, matrix and cross over rate, Mutation: mutation, mutation rate.

**Module-II**

**(5 Lectures)**

Variations of GA: Adaptive GA and Real coded GA (SR.); Ant colony optimization: Ant foraging behavior, combinatorial optimization, Routing in communication network, traveling sales man problem, graph partitioning, and nest building;

**Module-III**

**(5 Lectures)**

Particle swarm Optimization: basic principle, algorithm, flowchart. Variations of PSO: weighted, repulsive, stretched, comprehensive learning, combined effect PSO and colonial PSO. ;

**Module-IV**

**(10 Lectures)**

Bacterial Foraging Optimization: Foraging theory, social foraging, foraging behavior of E. coli bacteria, BFO algorithm, chemotactic, swarming, reproduction and elimination and dispersal. Variations of BFO: fuzzy BFO and Adaptive BFO. Artificial Immune System: overview, central and peripheral immune systems, immune network: clonal selection and its mathematical modeling, beyond clonal selection, danger theory, negative selection.

**Module-V**

**(10 Lectures)**

Applications: function optimization, adaptive system identification, Medical data forecasting, financial forecasting.

**Text Books:**

1. D.E. Goldberg, Genetic Algorithms in search, Optimization and machine learning, 1989.
2. R.C. Eberhart, Y.Sai and J. Kennedy, Swarm Intelligence , The Morgan Kaufmann Series in artificial Intelligence, 2001.

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**Reference Books:**

1. K.M. Passino, Biomimicry for optimization, control and automation, Springer-Verlag, London, UK, 2005.
2. D. Dasgupta, Artificial Immune Systems and their applications, 1998.
3. E. Bonabeau, M. Dorigo and G. Theraulaz, Swarm Intelligence: From natural to Artificial Systems,(Santa Fe Institute Studies in the Sciences of Complexity Proceedings), 1999.

**Course Outcomes:**

Learner will be able to...

1. Define, demonstrate an understanding of the basic principles and techniques of genetic algorithms, genetic programming and swarm intelligence;
2. Describe, Discuss and explain an understanding of how to apply techniques of genetic algorithms, genetic programming and swarm intelligence to optimization problems and problems that require machine learning;
3. Apply and compare different approaches to solve problems using Particle Swarm Optimization;
4. Apply and compare different approaches to solve problems using Bacterial Foraging Optimization.
5. Design, Construct and Apply hybrid Techniques for solving practical problems.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	3	2	1	2	1
<b>CO2</b>	3	3	2	1	2	1
<b>CO3</b>	3	3	2	1	2	1
<b>CO4</b>	3	3	2	1	2	1
<b>CO5</b>	3	3	2	1	2	1

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	3	2	1	2	1

**COMPUTING LAB-I**

**L-T-P: 0-0-3**

**Cr.-2**

Exposure to different:

- Web-based tools.
- Scripting languages.
- Develop GUI-based applications.
- File transfer and access using FTP, Telnet, etc.
- Implementation of real-time case studies, project, research and report submission.

**Course Outcomes**

1. Analyze the given problem and write an algorithm to implement the same
2. Demonstrate the use of appropriate scripting languages to simulate the problem.
3. Develop GUI-based application to represent the given problem.
4. Planning of new and effective methods to achieve models with less computational time
5. Compile a report of the project or research carried out.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	2	2	2	1	1
<b>CO2</b>	3	2	2	2	1	1
<b>CO3</b>	3	2	3	2	1	1
<b>CO4</b>	3	2	3	2	1	1
<b>CO5</b>	3	3	3	2	1	1

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	2	3	2	1	1

**COMPUTING LAB-II**

**L-T-P: 0-0-3**

**Cr.-2**

Exposure to different:

- Various simulation tools supporting to the elective papers offered
- Implement a project/research work and report submission

**Course Outcomes**

At the end of the course students will be able to

1. Recognize the basic operations of the simulation tool.
2. Write programs for solving problem related to the subject.
3. Demonstrate the fundamental concepts acquired from the subject into program.
4. Analyze and compare the simulation results to identify the scope of further research.
5. Implement and write a project/research work in the respective field

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	-	3	3	3	3
<b>CO2</b>	3	-	3	3	3	3
<b>CO3</b>	3	-	3	3	3	3
<b>CO4</b>	3	-	3	3	3	3
<b>CO5</b>	3	3	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	3	3	3	3	3

# **2<sup>nd</sup> SEMESTER**

## COMPUTATIONAL INTELLIGENCE

**L-T-P: 3-0-0**

**Cr.-3**

**Module 1:**

**(5 Lectures)**

Neural Network Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks, perception model, feed forward neural network, Back propagation,

**Module-2:**

**(5 Lectures)**

Adaline, Widrow-Hoff's Adaline model, Madaline, Unsupervised learning neural network: Hopfield neural network, Competitive learning, self-organizing feature map, Reinforcement learning: Q-learning, Temporal difference learning.

**Module 3:**

**(10 Lectures)**

Fuzzy Logic Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, membership functions, Fuzzy set theory and operations, Extension principle of fuzzy set, fuzzy inference, Fuzzy implications, fuzzy relation, fuzzy reasoning, fuzzy c-means clustering, fuzzy inference Engine on VLSI architecture, Defuzzification techniques

**Module 4:**

**(10 Lectures)**

Evolutionary Computing: Fundamentals of genetic algorithms: Encoding, Fitness functions, Reproduction Genetic Modeling: Cross cover, Inversion and deletion, Mutation operator, Bitwise operators, Bitwise operators used in GA. Convergence of Genetic algorithm. GA as an alternative to back propagation, Applications of GA in navigational planning of robots, Particle swarm optimization, ant-colony optimization, Bee colony optimization.

**Module 5:**

**(10 Lectures)**

Hybrid Systems Hybrid Systems: Neuro-fuzzy synergism, weakly coupled Neuro-fuzzy system, tightly coupled Neuro-Fuzzy System, fuzzy-GA synergism, Neuro-GA, Adaptation of neural learning algorithm using GA

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**Text Books:**

1. Computational Intelligence Principles, Techniques and Applications, Amit Konar, Springer publication.
2. Neural Networks, Fuzzy Logic, and Genetic Algorithm ( Synthesis and Application) S.Rajasekaran, G.A. Vijayalakshmi Pai, PHI
3. Principles of Soft Computing S.N.Sivanandam & S.N.Deepa, Wiley-India Edition

**Reference Books:**

1. Neuro Fuzzy and Soft Computing, J. S. R. JANG, C.T. Sun, E. Mizutani, PHI
2. Soft-computing, D.K.Pratihar, Alpha Science

**Course Outcomes:**

1. To know about the basic concept of computational intelligence and also their use in some real life situation.
2. To solve the problems using neural network techniques.
3. To find the solution using different fuzzy logic techniques.
4. To use genetic algorithms for different modeling.
5. To integrate the various evolutionary computing.

**Course Articulation Matrix**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	-	3	2	2	1
CO 2	3	-	3	2	2	1
CO 3	3	-	3	2	2	1
CO 4	3	-	3	2	2	1
CO 5	3	-	3	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	-	3	2	2	1

**ADVANCE SOFTWARE ENGINEERING**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(08 Lectures)**

**Managing software projects:** Overview to software Project, Software Product and Software Process, Project management concepts, Responsibility of Software Project Manager, Software Project Planning, Metrics for project size Estimation, Project Estimation Technique, Project scheduling technique (WBS, PERT, Gantt Chart, CPM) and tracking, Staffing, Overview to Risk Management, Risk Management Activities, Software Quality Assurance, Software Configuration management (SCM): Goals, Objectives, SCM Activities, SCM tools and Standards.

**Module-II**

**(08 Lectures)**

**Requirement Engineering and Specification:** Requirement Engineering Definition, Req. Engineering Technique, Software Requirement and its objectives, Req. Engineering Activities, Software Requirement Specification (SRS): Goals, quality Quality and characteristics of good SRS, benefits, Uses and Components of SRS, SRS Structure, Specification technique, Formal Specification, Algebraic specification and Model based specification.

**Module-III(08 Lectures)**

**Software Design Strategies and Methods:** What is good software Design? , Good Vs. Bad Design, Cohesion and Coupling: Classification of Cohesion and Coupling, Software Design Approach: Function Oriented Design and Object Oriented Design, Overview to SA/SD Methodology: Structure Analysis, Tools for structure Analysis, DFDs. Designing and Developing DFD Models Shortcoming of DFD, Extending DFD technique to Real time System, Structured Design, Tools for structure Design, Flow chart Vs. Structure chart, Transformation of DFD in to Structure Chart, Detail Design.

**Module-IV**

**(08 Lectures)**

**Object Oriented Software Engineering:** Conventional methods for software engineering: Design Concepts and principles. Architectural design, Component level Design, User Interface Design, software Coding and Testing Techniques, Software testing Strategies: Black box and White box testing, Integration and system testing, Object Oriented Concepts and principles, Object Oriented Analysis, Object Oriented Design, UML, UML Diagram: USE Case Model, CLASS Diagram, Inter action diagram, Activity Diagram, State Chart Diagram, Object Oriented Software Development and testing, Technical metrics for Object-Oriented Systems, Implementation and Maintenance.

**Module-V**

**(08Lectures)**

**Software Reliability and Quality Management:** Software reliability, Software Quality, Software Quality Management system, ISO Certification.

**Computer Aided Software Engineering:** Overview to CASE, CASE Tool Classification of CASE Tool, Characteristics of Case Tools, CASE for Future.

**Component Based Software Engineering:** Overview, Component based Software Development, Advantage and Limitations.

**Software Re-Engineering:** What is Software Re-Engineering? Benefits of Software Re-Engineering, Re-Engineering Activities, Software Reverse Engineering: Goals, Types of Reverse Engineering, Program Re-Structuring, Source Code Translation, Data Re-Engineering.

**Text Book:**

1. Rajib Mall, “Fundamental of Software Engineering”, PHI

**Reference Books:**

1. Roger S. Pressman, “Software Engineering: A Practitioners Approach”. Mc-Graw Hill Publication.
2. Ian Sommerville, “Software Engineering”, Pearson Education Asia.

**Course Outcome**

After successful completion of this course, students will be able to :

**CO1:**Analyzethe basic concepts of engineering principles in software development

**CO2:**Demonstrate the features of different lifecycle models. Analyze and build an appropriate process model for a given project using engineering principles at various phases of software development.

**CO3:** Translate a specification into a design, and identify the components to build the architecture for a given problem, all using an appropriate software engineering methodology

**CO4:** Evaluate a Project Management and estimation Plan and tabulate appropriate Testing Plans at different levels during the development of the software and apply Unified Modeling Language (UML) for representation of an object-oriented system using different modeling views

**CO5:** Apply requirement mapping strategies and various testing methods for development of high quality software product with the practice software maintenance.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	2	1	3	3	2	3
<b>CO2</b>	2	1	3	3	2	3
<b>CO3</b>	2	1	3	3	2	3
<b>CO4</b>	2	1	3	3	2	3
<b>CO5</b>	2	1	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	2	1	3	3	2	3

**WIRELESS NETWORK AND MOBILE COMPUTING**

**L-T-P: 3-0-0**

**Cr.-3**

**Module – I**

**(08 Lectures)**

Introduction to Wireless Network, Wired vs. Wireless Network, Applications, Satellite Communications: Parameters and Configurations, Orbit: Equatorial, Polar, Inclined, Geostationary, Medium Earth and Low Earth, , Frequency Bands, Capacity Allocation: Frequency Division, Time Division, Wireless Impairments, Hidden and Exposed terminal problem.

**Module – II**

**(08 Lectures)**

Introduction to Cellular Wireless Networks, Principles: Organization, Reuse, Capacity, Operation, Handoff, Effect of Handoff and Power Control, First-Generation Analog: Spectral Allocation, Operation and Advanced Mobile Phone Service Control Channels, Second-Generation TDMA: First and Second-Generation Cellular Systems, Time Division Multiple Access, Mobile Wireless TDMA Design, Global System for Mobile Communications, Architecture, Entities, Call Routing in GSM, GSM Addresses and Identifiers and Mobility Management, Second-Generation CDMA: Code Division Multiple Access, Mobile Wireless TDMA Design, Hard and Soft Handoff, IS-95, General Packet Radio Service: Packet Data Network, Quality of Service, Network Architecture, Data Services, Limitations and Applications.

**Module – III**

**(08 Lectures)**

Third-Generation Systems, Alternative Interfaces: Code Division Multiple Access-2000, Universal Mobile Telecommunications System, International Mobile Telecommunication-2000, Wireless LAN: Advantages, IEEE 802.11 Standards, Architecture, Frequency Hopping Spread Spectrum, Direct Sequence Spread Spectrum.

**Module – IV**

**(08 Lectures)**

Emerging Technologies: Bluetooth, IEEE 802.15, Mobile IP, Mobile Ad Hoc Network, Routing, Wireless Sensor Networks, Wireless Application Protocol, Cordless System, Wireless Local Loop, Security in Wireless network.

**Module-V**

**(08 Lectures)**

Pervasive web application architecture and server side programming.

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**Text Book**

1. W. Stallings, “Wireless Communications & Networks”, Second Edition, Pearson Education, 2007.
2. J. Schiller, “Mobile Communications”, Second Edition, Pearson Education, 2010.

**References**

1. S. Singhal, “The Wireless Application Protocol”, Addison Wesley, 2001.
2. T. S. Rappaport, “Wireless Communications: Principles & Practice”, Second Edition, Pearson Education, 2002.
3. C. E. Perkins, “Ad Hoc Networking”, Addison Wesley, 2000.

**Course Outcomes:**

After completing this course, the students should be able to:

1. Write various Wireless Network components and impairments, Evolution of Mobile System Architectures.
2. Demonstrate different Wireless Network Architecture and Protocols in different layers.
3. Organize the concepts behind generation evolution of sensor networks..
4. Analyse emerging technologies.
5. Produce server side programming.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	1	3	2	2	2	-
<b>CO2</b>	1	3	2	2	2	-
<b>CO3</b>	1	3	2	2	2	-
<b>CO4</b>	1	3	2	2	2	-
<b>CO5</b>	3	3	2	2	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	2	3	2	2	2	-

**IMAGE & VIDEO PROCESSING**

L-T-P: 3-0-0

Cr.-3

**Module-I:**

**(08 Lectures)**

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

**Module-II:**

**(08 Lectures)**

Image Enhancement: Enhancement by point processing, spatial filtering, Enhancement in the frequency domain, Color Image Processing

Image restoration: Degradation Models, PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.

Image Segmentation: Discontinuity detection, Edge linking and boundary detection, Thresholding, Region oriented segmentation, Use of motion for segmentation

**Module-III:**

**(08 Lectures)**

Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards

**Module-IV:**

**(08 Lectures)**

Video processing: Representation of Digital Video, Spatio-temporal sampling, Motion Estimation. Video Filtering, Video Compression, Video coding standards.

**Module-V:**

**(08 Lectures)**

Video Segmentation- Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts; spatial segmentation – motion-based; Video object detection and tracking.

**Text Books:**

1. Gonzaleze and Woods, ”Digital Image Processing “, 3rd edition, Pearson
2. Yao wang, Joem Ostarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI

**References:**

1. M Tamer Ozsu, P Valduriez; "Principles of Distributed Database Systems"; Pearson Education Pvt. Ltd., 2005, ISBN 81-7808-375-2.
2. J. L. Harrington; "Object Oriented Database Design Clearly Explained"; Morgan Kaufmann Publishers, 2001, ISBN 0-12-326428-6.
3. A K Majumder, P Bhattacharya; "Database Management Systems"; Tata McGraw-Hill PublishingCompany Limited, 2004, ISBN 0-07-462239-0

**Course Outcomes**

Upon completion of the course, the students will demonstrate the ability to:

CO1	Analyze the concepts of image formation.
CO2	Evaluate the methodologies for image segmentation, restoration and enhancement
CO3	Implement the compression techniques to compress the different raw data
CO4	Implement the various compression methods for video data.
CO5	Implement image and video processing algorithms using MATLAB or another programming language

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	3	2	1
CO2	3	1	2	3	2	1
CO3	3	1	2	3	2	1
CO4	3	1	2	3	2	1
CO5	3	1	2	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	2	3	2	1

**NETWORK SECURITY**

**L-T-P: 3-0-0**

**Cr.-3**

**Module I**

**(08 Lectures)**

Overview: Computer Security concepts, The OSI Security architecture, Security attacks. Security services, Security Mechanisms, Network Security model, Review of Symmetric and Asymmetric key cryptography

**Module II**

**(08 Lectures)**

Security at Application Layer: E-Mail Architecture, E-Mail Security, PGP, Application of PGP, MIME, S/MIME, Application of S/MIME

**Module III**

**(08 Lectures)**

Security at Transport Layer: Web Security issues, Secure Socket Layer (SSL): Architecture, services, Four Protocols, SSL Message format, Transport layer security (TLS), TLS protocols, HTTPS

**Module IV**

**(08 Lectures)**

Wireless Network Security: IEEE 802.11 wireless LAN overview, IEEE 802.11i Wireless LAN security, Wireless application protocol overview, wireless transport layer security, WAP End-to-End security

**Module V**

**(08 Lectures)**

Security at the Network Layer: IP Security overview, IP Security (IPSec) modes, AH and ESP protocol, IPv4 and IPv6, AH versus ESP, services provided by IPSec, Security association, Security policy, Internet Key Exchange (IKE), ISAKMP, Firewalls: Firewalls – Types, Comparison of Firewall Types, Firewall Configurations.Planning and Enforcing Security Policies: Planning Security Policies, Risk Analysis, Security Policies for an Organization, External Security.

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**Text Books:**

1. Cryptography and Network Security – by AtulKahate – TMH.
2. Data Communications and Networking- by Behourz A Forouzan

**Reference Book:**

1. Cyber Security Operations Handbook – by J.W.Rittiaghhouse and WilliamM.Hancok – Elseviers.

**Course Outcomes:**

At the end of the course students should be able to

1. Explain the principles of Security
2. Identify the security issues in the network and resolve it.
3. Implement different security algorithm
4. Analyze and classify various security protocols used in different layers.
5. Analyse the vulnerabilities in any computing system and hence be able to design a security solution for an organization.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	3
CO2	3	-	3	3	-	3
CO3	3	-	3	3	-	3
CO4	3	-	3	3	-	3
CO5	3	-	3	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	3	3	-	3

## CLOUD ARCHITECTURE

**L-T-P: 3-0-0**

**Cr.-3**

### **Module – I**

**(08 Lectures)**

Cloud Computing at a Glance: Vision, Reference Model, Characteristics, Benefits and Challenges Ahead, Developments: Virtualization, Web 2.0, Service-oriented Computing and Utility-Oriented Computing, Principles of Parallel and Distributed Computing: Eras of Computing, Elements of Parallel and Distributed Computing and Technologies for Distributed Computing.

### **Module – II**

**(08 Lectures)**

Virtualization: Characteristics of Virtualized Environments, Taxonomy, Pros and Cons and Technology Examples: Xen, VMware and Hyper-V, Cloud Computing Architecture: Reference Model, Types of Clouds, Open Challenges: Interoperability, Standards, Scalability, Fault Tolerance, Security, Trust and Privacy, Cloud Platforms in Industry: Amazon Web Services, Google App Engine and Microsoft Azure.

### **Module – III**

**(08 Lectures)**

Virtual Machine: Homogeneous and Heterogeneous, Task Scheduling, Mapping Heuristics: RR, CLS and CMMS

### **Module – IV**

**(08 Lectures)**

Workflow Scheduling: Workflow: Montage, Epigenomics, SIPHT, LIGO and CyberShake, Resource Allocation, Leases: Advance Reservation, Best Effort, Immediate, Deadline Sensitive and Negotiated, Haizea, Swapping and Backfilling, Resource Allocation Measures, Task Consolidation, Energy-Conscious Task Consolidation, MaxUtil, Energy-Aware Task Consolidation, Virtual Cluster, CPU Utilization Threshold and Sleep or Power Saving Mode, Virtual Machine Placement and Migration

### **Module – V**

**(08 Lectures)**

A Reference Model for Market-oriented Cloud Computing, Federated Clouds/Inter Cloud: Characterization, Federation Stack, Technologies for Cloud Federations, Cloud Applications: Healthcare, Protein Structure Prediction, Gene Expression Data Analysis for Cancer Diagnosis, Geoscience, Social Networking, Media Applications and Multiplayer Online Gaming.

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**Text Book:**

1. R. Buyya, C. Vecchiola and S. ThamaraiSelvi, Mastering Cloud Computing: Foundations and Applications Programming, Morgan Kaufmann, Elsevier, 2013.

**Reference Book:**

1. B. Sosinsky, Cloud Computing Bible, Wiley, 2011.
2. D. N. Chorafas, Cloud Computing Strategies, CRC Press, Taylor and Francis Group, 2011.
3. P. K. Pattnaik, M. R. Kabat and S. Pal, Fundamentals of Cloud Computing, Vikas Publishing House Pvt. Ltd., 2015.

**Course Outcomes**

Upon completion of the subject the students will demonstrate the ability to:

CO1	Develop and deploy cloud application using popular cloud platforms
CO2	Design and develop highly scalable cloud-based applications by creating and configuring virtual machines on the cloud and building private cloud.
CO3	Compare, contrast, and evaluate the key trade-offs between multiple approaches to cloud system design, and Identify appropriate design choices when solving real-world cloud computing problems.
CO4	Understand different cloud programming platforms and tools.
CO5	Be familiar with application development and deployment using cloud platforms

**1. Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**2. Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	2	2

**ADVANCED COMPUTER ARCHITECTURE**

**L-T-P: 3-0-0**

**Cr.-3**

**Module – I**

**(08 Lectures)**

**FUNDAMENTALS OF COMPUTER DESIGN**

Review of Fundamentals of CPU, Memory and IO – Trends in technology, power, energy and cost, Dependability – Performance Evaluation

**Module – II**

**(08 Lectures)**

**INSTRUCTION LEVEL PARALLELISM**

ILP concepts – Pipelining overview – Compiler Techniques for Exposing ILP – Dynamic Branch Prediction – Dynamic Scheduling – Multiple instruction Issue – Hardware Based Speculation – Static scheduling – Multi-threading – Limitations of ILP – Case Studies.

**Module – III**

**(08 Lectures)**

**DATA-LEVEL PARALLELISM**

Vector architecture – SIMD extensions – Graphics Processing units – Loop level parallelism.

**Module – IV**

**(08 Lectures)**

**THREAD LEVEL PARALLELISM**

Symmetric and Distributed Shared Memory Architectures – Performance Issues – Synchronization – Models of Memory Consistency – Case studies: Intel i7 Processor.

**Module – V**

**(08 Lectures)**

**TOPOLOGIES FOR PARALLEL PROCESSING**

Static and Dynamic topologies for parallel processing.

**Text Books:**

1. Computer Architecture – A quantitative approach By J.L Hennessy and D.A.Patterson, Morgan Kaufmann
2. Advanced Computer Architecture, by Kai Hwang Mc Graw Hill.

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**Reference Books:**

1. Introduction to Parallel Computing, 2nd Edition, Pearson Education by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar.

**Course Outcomes:**

After completing this course, the students should be able to:

1. Define the concept of parallelism,
2. Demonstrate Models of Parallelism and techniques to achieve parallelism.
3. Analyze Causes and Resolution of Hazards in pipelining,
4. Organize thread level parallelism.
5. Construct topologies for parallel processing

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	3	-
CO2	3	2	3	-	3	-
CO3	3	2	3	-	3	-
CO4	3	2	3	-	3	-
CO5	3	2	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	-	3	-

## DEEP LEARNING

**L-T-P: 3-0-0**

**Cr.-3**

### **Module-I**

**(08 Lectures)**

Introduction: Various paradigms of learning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques.

### **Module-II**

**(08 Lectures)**

Fundamental Concepts in Deep Learning, Introduction to Artificial Neural Networks, Classification with Two-Layers Artificial Neural Networks, Feedforward neural network: Artificial Neural Network, activation function, multi-layer neural network.

Training Neural Network: Risk minimization, loss function, backpropagation, regularization, model selection, and optimization.

### **Module-III**

**(08 Lectures)**

Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.

Deep Learning: Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.

### **Module-IV**

**(08 Lectures)**

**Probabilistic Neural Network:** Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders.

**Deep Learning research:** Object recognition, sparse coding, computer vision, natural language processing.

### **Module-V**

**(08 Lectures)**

**Deep Learning Tools:** Caffe, Theano, Torch

### **Text Books**

T1. Goodfellow, I., Bengio, Y., and Courville, A., Deep Learning, MIT Press, 2016..

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T2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.

**Reference Books**

R1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.

R2. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.

R3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

**Books on Optimization Techniques**

A. Ravindran, K. M. Ragsdell , and G. V. Reklaitis , ENGINEERING OPTIMIZATION: Methods and Applications , John Wiley & Sons, Inc. , 2016..

A. Antoniou, W. S. Lu, PRACTICAL OPTIMIZATION Algorithms and Engineering Applications, Springer, 2007.

**COURSE OUTCOME:**

Upon completion of the subject the students will demonstrate the ability to:

CO1	Gain knowledge of Deep learning along with its functions, operations, and the execution pipeline
CO2	Implement linear regression and gradient descent
CO3	Understand the concept of artificial neural networks, convolutional neural networks, and recurrent neural networks
CO4	Discuss how to speed up neural networks along with regularization techniques to reduce overfitting
CO5	Implement deep learning algorithms, and learn how to train deep networks

**1. Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	3	3	3	3	2	3
CO3	3	3	3	3	2	3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

2. Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	3	3	2	3

**INTRUSION DETECTION SYSTEMS**

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I (8 Lectures)**

History of Intrusion detection, Audit, Concept and definition, Internal and external threats to data, attacks, Need and types of IDS, Information sources Host based information sources, Network based information sources.

**Module-II (8 Lectures)**

Intrusion Prevention Systems, Network IDs protocol-based IDs, Hybrid IDs, Analysis schemes, thinking about intrusion. A model for intrusion analysis, techniques Responses requirement of responses, types of responses mapping responses to policy Vulnerability analysis, credential analysis non credential analysis

**Module-III (8 Lectures)**

Introduction to Snort, Snort Installation Scenarios, Installing Snort, Running Snort on Multiple Network Interfaces, Snort Command Line Options. Step-By-Step Procedure to Compile and Install Snort Location of Snort Files, Snort Modes Snort Alert Modes

**Module-IV (8 Lectures)**

Working with Snort Rules, Rule Headers, Rule Options, The Snort Configuration File etc. Plugins, Preprocessors and Output Modules, Using Snort with MySQL

**Module-V (8 Lectures)**

Using ACID and Snort Snarf with Snort, Agent development for intrusion detection, Architecture models of IDs and IPs.

**Text Book:**

1. RafeeqRehman : “ Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID,” 1st Edition, Prentice Hall .

**Reference Book:**

1. Christopher Kruegel, Fredrik Valeur, Giovanni Vigna: “Intrusion Detection and Correlation Challenges and Solutions”, 1st Edition, Springer, 2005.

2. Carl Endorf, Eugene Schultz and Jim Mellander “Intrusion Detection & Prevention”, 1st Edition, Tata McGraw-Hill, 2004.
3. Stephen Northcutt, Judy Novak: “Network Intrusion Detection”, 3rd Edition, New Riders Publishing, 2002.
4. T. Fahringer, R. Prodan, “A Text book on Grid Application Development and Computing Environment”. 6th Edition, KhannaPublihsers, 2012.

**Course Outcomes:**

At the end of the course students will be able to

1. Explain the need of intrusion detection system.
2. Apply the fundamental concepts of Network Protocol Analysis and demonstrate the skill to capture and analyze network packets.
3. Use of various protocol analyzers and Network Intrusion Detection Systems as security tools to detect network attacks and troubleshoot network problems.
4. Implement the ACID and SnortSnarf with Snort, Agent development for intrusion detection
5. Conceptualize the research aspects in the field of intrusion detection systems.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	3
CO2	3	-	3	3	-	3
CO3	3	-	3	3	-	3
CO4	3	-	3	3	-	3
CO5	3	-	3	3	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	-	3	3	-	3

## INTELLECTUAL PROPERTY RIGHTS

**L-T-P: 3-0-0**

**Cr.-3**

### **Module-I (Overview of Intellectual Property )**

**(08 Lectures)**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994

### **Module-II (Patents and Copyrights)**

**(08 Lectures)**

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board. Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

### **Module-III (Trademarks and Other forms of IP)**

**(08 Lectures)**

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.

### **Module-IV (Design)**

**(08 Lectures)**

Meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection **Geographical Indication** (GI) Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. **Plant Variety Protection** Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection

**Layout Design Protection** Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection.

**Module-V (Current Contour)**

**(08 Lectures)**

India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.

**Text book:**

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

**Reference book:**

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

**Course Outcomes**

Upon completion of the subject the students will demonstrate the ability to:

CO1	Understand the basics of the four primary forms of intellectual property rights.
CO2	Analyze the effects of intellectual property rights on society as a whole.
CO3	Assess and critique some basic theoretical justifications for each form of intellectual property protection.
CO4	Aware of acquiring the patent and copyright for their innovative works.
CO5	Able to get the knowledge of plagiarism in their innovations which can be questioned legally

**1. Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**2. Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	3	2	3	3	3

**REAL TIME SYSTEM DESIGN****L-T-P: 3-0-0****Cr.-3****Module-I****(08 Lectures)**

Introduction - Issues in Real Time Computing, Structure of a Real Time System, Task classes, Performance Measures for Real time Systems, Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms, RM algorithm with different cases-Priority ceiling precedence constraints- using of primary and alternative tasks.

**Module-II****(08 Lectures)**

Uniprocessor scheduling of IRIS tasks, Task assignment, Utilization balancing – Next fit- Bin packing- Myopic off-line - Focused addressing and bidding- Buddy strategy- Fault Tolerant Scheduling.-Aperiodic scheduling - Spring algorithm, Horn algorithm- Bratley. - Sporadic scheduling.

**Module-III****(08 Lectures)**

Introduction – VTCSMA – PB CSMA- Deterministic collision resolution protocol- DCR for multi packet messages- dynamic planning based- Communication with periodic and aperiodic messages.

**Module-IV****(08 Lectures)**

Basic Definition, Real time Vs General purpose databases, Main Memory Databases, Petri nets and applications in real-time modeling, Air traffic controller system – Distributed air defense system.

**Module-V****(08 Lectures)**

Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Twophase Approach to improve Predictability, Maintaining Serialization Consistency, and Databases for Hard Real Time System.

**References Books**

1. C.M. Krishna, Kang G. Shin, “Real Time Systems”, Tata McGraw - Hil, 2010.

2. Giorgio C. Buttazzo , “Hard real-time computing systems: predictable scheduling algorithms and applications” , Springer, 2008.

3. C. Siva Ram Murthy, G. Manimaran, “Resource management in real-time systems and networks”, PHI, 2009

**Course Outcomes**

Upon completion of the subject the students will demonstrate the ability to:

CO1	Explain fundamental principles for programming of real time systems with time and resource limitations.
CO2	Describe the foundation for programming languages developed for real time programming.
CO3	Account for how real time operating systems are designed and functions.
CO4	Describe what a real time network is.
CO5	Use real time system programming languages and real time operating systems for real time applications.

**3. Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	2
CO2	3	3	2	3	3	2
CO3	3	3	2	3	3	2
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**4. Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	3	2

## PARALLEL PROCESSING

**L-T-P: 3-0-0**

**Cr.-3**

### **Module – I**

**(8 Lectures)**

Introduction: Need for High Performance Computer, Motivation for Parallelism, Methods to achieve High Performance, Parallel Programming Platforms- Control structure of parallel platform, Pipelining, Superscalar Architecture, Super Pipelined Architecture, VLIW Architecture, Pipelining vs. Parallelism.

### **Module – II**

**(5Lectures)**

Basic Multiprocessor Architecture: Flynn's Classification, UMA, NUMA, Distributed Memory Architecture, Array Processor, Vector Processors.

### **Module – III**

**(7Lectures)**

Interconnection Networks for Parallel Computer: Static Interconnection Networks, Network Topologies, Evaluation of Static Network, Dynamic Interconnection Networks, Evaluation of Dynamic Network, Routing Mechanism for Interconnection Network.

### **Module – IV**

**(10 Lectures)**

Designing Parallel Algorithms: Temporal Parallelism, Data Parallelism, Task Decomposition, Concurrency, Granularity selection, Inter-Task Dependency, Dependency Graph, Parallel Algorithm Models, Models of Computation, Performance Metrics of Parallel Algorithm, Amdahl's Law.

### **Module – V**

**(10 Lectures)**

Parallel Programming: Sorting, Searching, Matrix Multiplication, Data dependency and Loop Optimizations, Message Passing Programming, Shared Memory Programming, Data Parallel Programming, Performance evaluation of Parallel Computer.

### **Text Book**

1. A. Grama, A. Gupta, G. Karypis, V. Kumar, Introduction to Parallel Computing, Pearson.
2. M. J. Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw-Hill

### **References:**

1. V. Rajaraman, C. S. R. Murthy, Parallel Computers Architecture and Programming, PHI.
2. W. P. Petersen, P. Arbenz, Introduction to Parallel Computing, Oxford University Press.
3. B. Wilkinson, M. Allen, Parallel Programming, Pearson.
4. H. Attiya, J. Welch, Distributed Computing Fundamentals, Simulations and Advanced Topics, Wiley.
5. T. G. Lewis, Parallel Programming: A Machine-Independent Approach, IEEE Computer Society Press.

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6. M. R. Bhujade, Parallel Computing, New Age.

### Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Calculate performance of the system and acquire knowledge about high performance computer and pipeline architecture
CO2	Select different particular processor architecture for their design issues.
CO3	Perform the performance evaluation of various interconnection networks
CO4	Design efficient parallel algorithms for efficient parallel processing
CO5	Design optimized parallel programming for their requirements.

#### 1. Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

#### 2. Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	3	2	3	2	2

### COMPUTING LAB-III

**L-T-P: 0-0-3**

**Cr.-2**

Exposure to different:

- Software Engineering Tools like IBM Rational Rose
- Development of SRS according to a case study
- Design of DFD/UML diagram.
- Implementation of project/research work and report submission

#### Course Outcomes-

1. Demonstrate the use of different tools.
2. Analyse different particular case study
3. Design of SRS and diagram.
4. Solve different newer problems
5. Compile a report of the project or research carried out.

#### Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	1
CO2	3	2	2	2	2	1
CO3	3	2	3	2	2	1
CO4	3	2	3	2	2	1
CO5	3	3	3	2	2	1

#### Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6
Course	3	2	3	2	2	1

**COMPUTING LAB-IV**

**L-T-P: 0-0-3**

**Cr.-2**

Exposure to different:

- Different Simulation tools for implementing research work
- Implementation of project/research work and report submission

**Course Outcomes**

1. Demonstrate the use of different tools.
2. Analyse different particular case study
3. Solve different newer problems
4. Planning of new and effective methods to achieve models with less computational time
5. Compile a report of the project or research carried out.

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	2	2	2	1	2
<b>CO2</b>	3	2	2	2	1	2
<b>CO3</b>	3	2	3	2	1	2
<b>CO4</b>	3	2	3	2	1	2
<b>CO5</b>	3	3	3	2	1	2

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	2	3	2	1	1

# **3<sup>rd</sup> SEMESTER**

## **PATTERN RECOGNITION**

L-T-P: 3-1-0

Cr.-4

**Module 1:** **(10 Lectures)**

Probability Distributions: Binary variables, multinomial variables, The Gaussian distribution, Bayes decision theory, Bayesian Classification for Normal Distributions, Maximum Likelihood Parameter Estimation, Maximum a Posteriori Probability Estimation, Maximum Entropy Estimation, Linear Classifiers: Introduction, Linear Discriminant functions, Least square Methods, Mean Square Estimation Revised

**Module 2:** **(9 Lectures)**

Non-Linear Classifiers: Two-Layer Perceptron, Three –Layer Perceptrons, Algorithm based on Exact Classification of the Training Set, The Backpropagation Algorithm, Variations on the Backpropagation Theme, Radial Basis Function Networks (RBF).

**Module 3:** **(8 Lectures)**

Feature Selection: Introduction, Pre-processing, Feature selection based on statistical hypothesis testing, The Receiver Operating Characteristics CROC Curve, Feature generation: Introduction, Basic vectors and images, The singular value decomposition

**Module 4:** **(7 Lectures)**

Template matching: Introduction, Measure based on Optimal path Searching Techniques, Measures based on Correlations, Context-dependent Classification: Introduction, The Bayesian classifier, Markov chain models, Hidden Markov Models, System evaluation.

**Module 5:** **(6 Lectures)**

Clustering Algorithms: Sequential algorithm, Agglomerative algorithm based on matrix theory, Fuzzy clustering algorithm, k-Means, Clustering using Genetic algorithm, Cluster validity: Introduction, Hypothesis testing in cluster validity, Relative criteria,

**Text Books:**

1. SergiosTheodoridis, Konstantinos Koutroumba,s Pattern Recognition, Elsevier
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer.

**Reference Books:**

1. Pattern Recognition Principles by J.T. Tou and R.C. Gonzalez, Addison Wesley
2. Pattern Recognition and Image Analysis by Gose, Johnsonbaugh, Jost, PHI

**Course Outcomes:**

Learner will be able to...

1. Define mathematical and statistical techniques used in pattern recognition
2. Demonstrate basic Non-linear classifier
3. Analyze various feature selection techniques used in pattern recognition
4. Construct machine learning algorithms in real life problems.
5. Implement the various clustering algorithms

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	3	3	3
CO2	-	-	2	3	3	3
CO3	2	-	2	-	3	3
CO4	3	-	3	3	2	3
CO5	3	-	3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6
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Course	3	-	3	3	3	3
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### E-COMMERCE & ERP

**L-T-P: 3-0-0**

**Cr.-3**

**Module-I**

**(08 Lectures)**

Introduction Overview of e-commerce, Structure, Mechanism and Impacts

**INTERNET & WWW** – Overview of Internet, History & Architecture of Web SYSTEM, URL, HTTP, Static & Dynamic Web Pages.

**CLIENT SIDE PROGRAMMING** – Important Factors, Design & Production of Web page, HTML – Overview, Structure, Text Formatting, Links, Tables, Images, Frames, Form, Java Script.

**SERVER SIDE PROGRAMMING – Servlet Fundamentals** (3-Tier Model, CGI, ASP, API); **Database Connectivity** (RDBMS, JDBC Perspectives, Advanced JDBC Servlet) and **Session Tracking**

**Module-II**

**(08 Lectures)**

**BASIC CRYPTOGRAPHY FOR ENABLING E-COMMERCE** – Security concerns & requirements, Encryption (Private & Public key), RSA, Cipher, Message Digest, Digital Signature & its Standard, Authentication.

**INTERNET SECURITY** – IPsec, AH & ESP Service, Firewalls, SSL.

**ADVANCE TECHNOLOGIES FOR E-COMMERCE** – Introduction to mobile agents, WAP, XML, Data Mining.

**INTERNET PAYMENT SYSTEMS** – Characteristics, SET Protocol, e-Cash, e-Check, Micropayment Systems, Overview of Smartcard & Mondex.

**Module-III:**

**(08 Lectures)**

B2B e-commerce: company centric B2B and e-procurement, public B2B exchanges and portals, e-supply chains, collaborative commerce, and intra business E-Commerce, Support Services: Auctions, and other support services, Customer Relationship Management (CRM), online advertising. EC models and applications: e-government, e-learning, and other EC applications,

mobile commerce and pervasive computing. Agent Technology: software agents, multi-agent systems, shopping agents. Middle agents and Mobile Agents.

#### **Module-IV**

**(08 Lectures)**

**CONSUMER ORIENTED E-COMMERCE** – Traditional vs. e-Retailing and their key success factors; e-Retailing - Benefits, Features & Models, Developing consumer oriented e-commerce systems, The PASS Model.

**BUSINESS ORIENTED E-COMMERCE** – Features of B2B e-Commerce, Business Models, Integration.

**E-SERVICES** – Categories, Web enabled Services(e-banking, e-stock trading, e-investment, e-education), Matchmaking Services (Travel Services, e-jobs, e-employment, etc), e-Entertainment, Auctions(C2C and B2B), Overview of Web Advertising & Web Publishing.

#### **Module-V**

**(08 Lectures)**

**Enterprise Resource Planning (ERP):** Introduction, Enterprise Resource Planning, Features, Trends, the implementation challenges and Overview of Commercial Software, Business Process Redesign, Knowledge Engineering and Data Warehouse Business Modules: Finance, Manufacturing (Production), Human Resources, Plant Maintenance, Materials, Management, Quality Management Sales & Distribution ERP Package. ERP Market: ERP Market Place, SAP AG, People Soft, BAAN, Oracle Corporation. ERP-Present and Future: Enterprise Application Integration (EAI).ERP and E-Commerce, ERP and Internet, Future Directions in ERP.

#### **Text Book:**

1. E-Commerce Fundamentals & Applications by Henry Chan, Raymond Lee, Tharam Dillon, John Wiley & Sons, Ltd.

#### **Reference Book:**

1. E-Commerce, MM Oka, EPH
2. Kalakotia, Whinston: Frontiers of Electronic Commerce, Pearson Education.
3. Bhaskar Bharat : Electronic Commerce – Technologies & Applications, TMH
4. Loshin Pete, Murphy P.A.: Electronic Commerce, Jaico Publishing Housing
5. Enterprise Resource Planning :Fundamentals of Design and Implementation  
By Ganesh, K., Mohapatra, S., Anbuudayasankar, S.P., Sivakumar, P., **Springer**

#### **Course Outcome**

At the end of this course, students will be able to :

**CO1:** understanding of the foundations and importance of E-commerce and basic network architecture of internet, WWW, client side and serverside programming tools for building E-Commerce applications

**CO2:** Understand basic cryptography for enabling E-Commerce, Internet Security, advance technologies for e-commerce and Internet payment system.

**CO3:** understand B2B e-commerce e-supply chains, collaborative commerce, and intra business E-Commerce, CRM and Mobile Agents.

**CO4:** Analyze the impact and use of consumer oriented e-commerce, business oriented e-commerce, e-services.

**CO5:** Recognize and discuss global E-commerce issues, characterize current trends in ERP system development, the implementation challenges and Overview of Commercial Software

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	3	2	2	1	1	2	-	-	-	1
<b>CO2</b>	3	3	3	2	2	1	1	2	-	-	-	1
<b>CO3</b>	3	3	3	2	2	1	1	2	-	-	-	1
<b>CO4</b>	3	3	3	2	2	1	1	2	-	-	-	1
<b>CO5</b>	3	3	3	2	2	1	1	2	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>Course</b>	3	3	3	2	2	1	1	2	-	-	-	1

## BIOINFORMATICS

**L-T-P: 3-0-0**

**Cr.-3**

### **Module-I**

**(08 Lectures)**

Basic concepts of Molecular Biology: Cellular Architecture, Nucleic Acids (RNA & DNA), DNA replication, Repair Cellular and recombination. Transcription, Translation, Genetic code, Gene expression, Protein structure and function, Molecular biology tools. Statistical methods: Estimation, Hypothesis testing, Random walks, Markov Models (HMM).

### **Module-II**

**(08 Lectures)**

Suffix Trees: Definitions and examples, Ukkonen's linear-time suffix tree algorithm, Applications (exact string matching, longest common sub strings of two strings, Recognizing DNA

### **Module-III**

**(08 Lectures)**

Pair-wise Sequence Alignment (Edit distance Dynamic Programming Calculation of edit distance, string similarity, gaps). Pair-wise sequence alignment (local), HMM for pair-wise alignment.

### **Module-IV**

**(08 Lectures)**

Multiple String Alignment: Need of MSA, Family & Super family representation, multiple sequence comparison for structural inferences, multiple alignments with sum-of-pairs, consensus objective functions. Profile HMM for multiple sequence alignment. Database searching for similar sequence (FASTA, BLAST), PAM, BLOSUM, substitution matrices.

**Module-V**

**(08 Lectures)**

Phylogenetic Reconstruction: Phylogenetic Trees, Parsimony methods, Distance methods, Evolutionary models, Hierarchical clustering method, Maximum Likelihood method, Model comparison, Fragment Assembly Problem.

**TextBooks:**

1. N.C. Jones & P.A. Pevzner – An introduction to Bioinformatics Algorithms. The MIT Press-2004.
2. D. Gusfield-Algorithms on Strings, Trees and sequences, Cambridge University Press, 1997.
3. R. Durbin, S. Eddy, A. Krugh, G. Mithison-Biological Sequence analysis, Cambridge University Press,1998.
4. J. Setubal and J. Meidanis-Introduction to Computational Molecular Biology PWS Publishing Company, 1997.
5. W.J. Ewens& G.R. Grant-Statistical methods in Bioinformatics-Springer-1989.

**Reference Book:**

1. M.S. Waterman – Introduction to Computational Biology – Chapman & Hall CRC.

**Course Outcomes:**

At the end of the course students will be able to

1. Describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyse and discuss the results in light of molecular biological knowledge.
2. To acquire the knowledge of the application of bioinformatics and biological databases.
3. Express the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming.
4. Predict the secondary and tertiary structures of protein sequences.
5. Use the different computational tools for automation of complex problem solving in real research problems.

**Course Articulation Matrix**

	PO01	PO02	PO03	PO04	PO05	PO06
CO01	3	3	3	3	2	1

CO02	3	3	3	2	3	1
CO03	3	3	3	3	2	1
CO04	3	3	2	2	3	1
CO05	3	3	3	3	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

	PO01	PO02	PO03	PO04	PO05	PO06
COURSE	3	3	3	3	3	1

**INFORMATION THEORY AND CODING**

**L-T-P: 3-0-0**

**Cr.-3**

**Module – I**

**(10 Lectures)**

Introduction to information Theory, Information and entropy, properties of entropy of a binary memory less source.

**Module – II**

**(8Lectures)**

Measure of Information, Source Coding, Shannon-Fano coding, Huffman coding, Lempel ZIV coding,

**Module – III**

**(6Lectures)**

Channel coding, Channel capacity, noisy channel coding theorem for DMC.

**Module – IV**

**(8Lectures)**

Linear block codes, generator matrices, parity check matrices, encoder syndrome and error detection- minimum distance, error correction and error detection capabilities, cyclic codes, coding and decoding.

**Module – V**

**(8Lectures)**

Coding convolutional codes, encoder, generator matrix, transform domain representation state diagram, distance properties, maximum likelihood decoding, Viterbi decoding, sequential decoding, and interleaved convolutional codes.

**Text Book:**

1. Elements of Information Theory, T.M.Cover, J.A.Thomas, Wiley
2. R.J.McEliece, The Theory of Information and Coding, Addison-Wesley.

**References**

1. S. Roman, *Coding and Information Theory*, Springer, 1992.

2. R. J. McEliece, *The Theory of Information and Coding*, Cambridge Univ Press, 2004.
3. R. Bose, *Information Theory Coding and Cryptography*, Tata McGraw Hill, 2003.
4. Simon Haykin, *Communication Systems*: John Wiley & Sons. Pvt. Ltd.
5. Taub& Schilling, *Principles of Communication Systems*: Tata McGraw-Hill
6. Das, Mullick& Chatterjee, *Principles of Digital Communication*: Wiley Eastern Ltd.

**Course Outcomes·**

1. Determine the amount of information per symbol and information rate of a discrete memoryless source
2. Design lossless source codes for discrete memoryless source to improve the efficiency of information transmission.
3. Evaluate the information capacity of discrete memoryless channels and determine possible code rates to achievable on such channels.
4. Select a suitable lossy data compression technique for a given situation
5. Demonstrate information theoretic results as fundamental limits on performance of communication systems

**Course Articulation Matrix**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>CO1</b>	3	3	2	1	2	1
<b>CO2</b>	3	3	2	1	2	1
<b>CO3</b>	3	3	3	1	2	1
<b>CO4</b>	3	2	3	1	2	1
<b>CO5</b>	3	2	3	1	2	1

**Program Articulation Matrix row for this Course**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
<b>Course</b>	3	3	3	1	2	1

## VLSI DESIGN

**L-T-P: 3-0-0**

**Cr.-3**

### **Module – I**

**(8 Lectures)**

VLSI physical design: VLSI design cycle, Physical design cycle, *Design styles*: Full custom, Standard cell, Gate arrays, FPGA, *System Packaging styles*: Die package style, PCB, Multichip modules, Wafer scale integration, design rules.

Design and Fabrication: Fabrication materials, Transistor fundamentals, Fabrication processes.

### **Module – 2**

**(6 Lectures)**

Partitioning: Levels of partitioning, *Partitioning Algorithms*: Kernighan-Lin algorithm, F-M algorithm, Goldberg-Burstein algorithm, Component replication, Ratio cut.

### **Module – 3**

**(6 Lectures)**

Floor planning: Floor plans, Floor planning problems, *Sliceable floor plans*: Slicing trees, Normalized postfix notations, Rectangular Dualization, *Non-Sliceable floor plans*: Z-cuts, Sequence pair, O-tree, Corner block list, Twin binary sequence.

### **Module – 4**

**(8 Lectures)**

Placement: Levels of placement, objectives, placement for hi-performance systems, *Methods for VLSI placement*: Cluster growth, Partitioning based VLSI placement algorithm, Simulated Annealing, Simulated Evolution, Force-Directed method.

### **Module – 5**

**(12 Lectures)**

Routing: Objectives, Constraints, Design specifications, Steps of routing, Phases of routing.

*Global routing*: Grid graph model, Checker's board model, Channel intersection graph model, *Global routing algorithms*: Maze routing algorithms, Lee's algorithm, Souk up's algorithm, Line probe algorithm.

*Detailed routing:* Routing region, Routing models, Terminologies, HCG, VCG, *Two layer channels routing algorithms:* Left edge algorithm, Constraint graph based routing algorithms, Greedy channel router.

**Text:**

1. Algorithms for VLSI Physical Design Automation.  
By Naveed A. Sherwani, Springer.

**References:**

1. VLSI Design  
By D. Das, Oxford University press
2. An Introduction to VLSI Physical Design.  
By M. Sarrafzadeh and C. K. Wong, McGraw-Hill.
3. Algorithms for VLSI design automation.  
By S. H. Gerez, Wiley.

**Course Outcomes:**

After completing this course, the students should be able to:

1. Organize different Design and Packaging style of VLSI physical design.
2. Understand different levels of partitioning.
3. Demonstrate the Floor planning concepts for VLSI design.
4. Analyze the levels and methods of placement.
5. Formulate different Routing problems.

**Course Articulation Matrix**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	3	-	3	-	-	-
CO2	3	3	3	3	1	-	2	-	1	-	-	-
CO3	3	3	3	3	1	-	2	-	3	-	-	-
CO4	3	3	3	3	1	-	3	-	2	-	-	-
CO5	3	3	3	3	1	-	2	-	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

**Program Articulation Matrix row for this Course**

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DEPARTMENT OF INFORMATION TECHNOLOGY

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	-	2	-	2	-	-	-