

<b>INTERNET OF THINGS</b> (Effective from the academic year 2018 -2019) <b>SEMESTER – VIII</b>			
<b>Course Code</b>	<b>18CS81</b>	<b>CIE Marks</b>	40
<b>Number of Contact Hours/Week</b>	3:0:0	<b>SEE Marks</b>	60
<b>Total Number of Contact Hours</b>	40	<b>Exam Hours</b>	03
<b>CREDITS –3</b>			
<b>Course Learning Objectives:</b> This course (18CS81) will enable students to:			
<ul style="list-style-type: none"> <li>• Assess the genesis and impact of IoT applications, architectures in real world.</li> <li>• Illustrate diverse methods of deploying smart objects and connect them to network.</li> <li>• Compare different Application protocols for IoT.</li> <li>• Infer the role of Data Analytics and Security in IoT.</li> <li>• Identifysensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.</li> </ul>			
<b>Module 1</b>			<b>Contact Hours</b>
What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. <b>Textbook 1: Ch.1, 2</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 2</b>			
Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. <b>Textbook 1: Ch.3, 4</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 3</b>			
IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. <b>Textbook 1: Ch.5, 6</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 4</b>			
Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment <b>Textbook 1: Ch.7, 8</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 5</b>			
IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT			08

<p>Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.</p> <p><b>Textbook 1: Ch.12</b></p> <p><b>Textbook 2: Ch.7.1 to 7.4, Ch.8.1 to 8.4, 8.6</b></p> <p><b>RBT: L1, L2, L3</b></p>	
<p><b>Course Outcomes:</b> The student will be able to :</p> <ul style="list-style-type: none"> <li>• Interpret the impact and challenges posed by IoT networks leading to new architectural models.</li> <li>• Compare and contrast the deployment of smart objects and the technologies to connect them to network.</li> <li>• Appraise the role of IoT protocols for efficient network communication.</li> <li>• Elaborate the need for Data Analytics and Security in IoT.</li> <li>• Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.</li> </ul>	
<p><b>Question Paper Pattern:</b></p> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full Question consisting of 20 marks</li> <li>• There will be 2 full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub questions covering all the topics under a module.</li> <li>• The students will have to answer 5 full questions, selecting one full question from each module.</li> </ul>	
<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "<b>IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things</b>", 1<sup>st</sup>Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)</li> <li>2. Srinivasa K G, "<b>Internet of Things</b>", CENGAGE Learning India, 2017</li> </ol>	
<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Vijay Madiseti and ArshdeepBahga, "<b>Internet of Things (A Hands-on-Approach)</b>", 1<sup>st</sup>Edition, VPT, 2014. (ISBN: 978-8173719547)</li> <li>2. Raj Kamal, "<b>Internet of Things: Architecture and Design Principles</b>", 1<sup>st</sup> Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)</li> </ol>	
<p><b>Mandatory Note:</b></p> <p>Distribution of CIE Marks is as follows (Total 40 Marks):</p> <ul style="list-style-type: none"> <li>• 20 Marks through IA Tests</li> <li>• 20 Marks through practical assessment</li> </ul> <p><b>Maintain a copy of the report for verification during LIC visit.</b></p>	
<p><b>Possible list of practicals:</b></p> <ol style="list-style-type: none"> <li>1. Transmit a string using UART</li> <li>2. Point-to-Point communication of two Motes over the radio frequency.</li> <li>3. Multi-point to single point communication of Motes over the radio frequency.LAN (Sub-netting).</li> <li>4. I2C protocol study</li> <li>5. Reading Temperature and Relative Humidity value from the sensor</li> </ol>	

<b>MOBILE COMPUTING</b> (Effective from the academic year 2018 -2019) <b>SEMESTER – VIII</b>			
<b>Course Code</b>	<b>18CS821</b>	<b>CIE Marks</b>	40
<b>Number of Contact Hours/Week</b>	3:0:0	<b>SEE Marks</b>	60
<b>Total Number of Contact Hours</b>	40	<b>Exam Hours</b>	03
<b>CREDITS –3</b>			
<p><b>Course Learning Objectives:</b> This course (18CS821) will enable students to:</p> <ul style="list-style-type: none"> <li>• Define concepts of wireless communication.</li> <li>• Compare and contrast propagation methods, Channel models, capacity calculations multiple antennas and multiple user techniques used in the mobile communication.</li> <li>• Explain CDMA, GSM. Mobile IP, Wimax and Different Mobile OS</li> <li>• Illustrate various Markup Languages CDC, CLDC, MIDP; Programming for CLDC, MIDlet model and security concerns</li> </ul>			
<b>Module 1</b>			<b>Contact Hours</b>
<p>Mobile Computing Architecture: Architecture for Mobile Computing, 3-tier Architecture, Design Considerations for Mobile Computing. Emerging Technologies: Wireless broadband (WiMAX), Mobile IP: Introduction, discovery, Registration, Tunneling, Cellular IP, Mobile IP with IPv6. Wireless Networks : Global Systems for Mobile Communication (GSM): GSM Architecture, Entities, Call routing in GSM, PLMN Interface, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management, GSM Frequency allocation. Short Service Messages (SMS): Introduction to SMS, SMS Architecture, SMMT, SMMO, SMS as Information bearer, applications</p> <p><b>Textbook1: 2.4 - 2.6, 4.4 - 4.6, 5, 6.</b> <b>RBT: L1, L2</b></p>			08
<b>Module 2</b>			
<p>GPRS and Packet Data Network, GPRS Network Architecture, GPRS Network Operations, Data Services in GPRS, Applications for GPRS, Billing and Charging in GPRS. Spread Spectrum technology, IS-95, CDMA versus GSM, Wireless Data, Third Generation Networks, Applications on 3G, Mobile Client: Moving beyond desktop, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices.</p> <p><b>Textbook 1: 7,9.2 - 9.7, 12.2 - 12.6</b> <b>RBT: L1, L2</b></p>			08
<b>Module 3</b>			
<p>Mobile OS and Computing Environment: Smart Client Architecture, The Client: User Interface, Data Storage, Performance, Data Synchronization, Messaging. The Server: Data Synchronization, Enterprise Data Source, Messaging. Mobile Operating Systems: WinCE, Palm OS, Symbian OS, Linux, Proprietary OS Client Development: The development process, Need analysis phase, Design phase, Implementation and Testing phase, Deployment phase, Development Tools, Device Emulators</p> <p><b>Textbook 2: 7, 8.</b> <b>RBT: L1, L2</b></p>			08
<b>Module 4</b>			
<p>Building Wireless Internet Applications: Thin client overview: Architecture, the client, Middleware, messaging Servers, Processing a Wireless request, Wireless Applications</p>			08

Protocol (WAP) Overview, Wireless Languages: Markup Languages, HDML, WML, 10 Hours HTML, cHTML, XHTML, VoiceXML. <b>Textbook 2: 11, 12, 13</b> <b>RBT: L1, L2</b>	
<b>Module 5</b>	
J2ME: Introduction, CDC, CLDC, MIDP; Programming for CLDC, MIDlet model, Provisioning, MIDlet life-cycle, Creating new application, MIDlet event handling, GUI in MIDP, Low level GUI Components, Multimedia APIs; Communication in MIDP, Security Considerations in MIDP. <b>Textbook 1: 15.1 - 15.10</b> <b>RBT: L1, L2</b>	08
<b>Course Outcomes:</b> The student will be able to :	
The students shall able to: <ul style="list-style-type: none"> <li>• Explain state of art techniques in wireless communication.</li> <li>• Discover CDMA, GSM. Mobile IP, Wimax</li> <li>• Demonstrate program for CLDC, MIDP let model and security concerns</li> </ul>	
<b>Question paper pattern:</b> The question paper will have ten questions. There will be 2 questions from each module. Each question will have questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
<b>Text Books:</b> <ol style="list-style-type: none"> <li>1. Ashok Talukder, Roopa Yavagal, Hasan Ahmed: Mobile Computing, Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill, 2010.</li> <li>2. Martyn Mallik: Mobile and Wireless Design Essentials, Wiley India, 2003</li> </ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Raj kamal: Mobile Computing, Oxford University Press, 2007.</li> <li>2. Iti Saha Misra: Wireless Communications and Networks, 3G and Beyond, Tata McGraw Hill, 2009.</li> </ol>	

<b>STORAGE AREA NETWORKS</b> (Effective from the academic year 2018 -2019) <b>SEMESTER – VII</b>			
<b>Course Code</b>	<b>18CS822</b>	<b>CIE Marks</b>	40
<b>Number of Contact Hours/Week</b>	3:0:0	<b>SEE Marks</b>	60
<b>Total Number of Contact Hours</b>	40	<b>Exam Hours</b>	03
<b>CREDITS –3</b>			
<b>Course Learning Objectives:</b> This course (18CS822) will enable students to:			
<ul style="list-style-type: none"> <li>• Evaluate storage architectures,</li> <li>• Define backup, recovery, disaster recovery, business continuity, and replication</li> <li>• Examine emerging technologies including IP-SAN</li> <li>• Understand logical and physical components of a storage infrastructure</li> <li>• Identify components of managing and monitoring the data center</li> <li>• Define information security and identify different storage virtualization technologies</li> </ul>			
<b>Module 1</b>			<b>Contact Hours</b>
<b>Storage System: Introduction to Information Storage:</b> Information Storage, Evolution of Storage Architecture, Data Center Infrastructure, Virtualization and Cloud Computing. <b>Data Center Environment:</b> Application Database Management System (DBMS), Host (Compute), Connectivity, Storage, Disk Drive Components, Disk Drive Performance, Host Access to Data, Direct-Attached Storage, Storage Design Based on Application <b>Textbook1 : Ch.1.1 to 1.4, Ch.2.1 to 2.10</b> <b>RBT: L1, L2</b>			08
<b>Module 2</b>			
<b>Data Protection - RAID :</b> RAID Implementation Methods, RAID Array Components, RAID Techniques, RAID Levels, RAID Impact on Disk Performance, RAID Comparison. <b>Intelligent Storage Systems :</b> Components of an Intelligent Storage System, Types of Intelligent Storage Systems. <b>Fibre Channel Storage Area Networks - Fibre Channel:</b> Overview, The SAN and Its Evolution, Components of FC SAN. <b>Textbook1 : Ch.3.1 to 3.6, Ch. 4.1, 4.3, Ch. 5.1 to 5.3</b> <b>RBT: L1, L2</b>			08
<b>Module 3</b>			
<b>IP SAN and FCoE:</b> iSCSI, FCIP, <b>Network-Attached Storage:</b> General-Purpose Servers versus NAS Devices, Benefits of NAS, File Systems and Network File Sharing, Components of NAS, NAS I/O Operation, NAS Implementations, NAS File-Sharing Protocols, Factors Affecting NAS Performance <b>Textbook1 : Ch.6.1, 6.2, Ch. 7.1 to 7.8</b> <b>RBT: L1, L2</b>			08
<b>Module 4</b>			
<b>Introduction to Business Continuity:</b> Information Availability, BC Terminology, BC Planning Life Cycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions, <b>Backup and Archive:</b> Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Architecture, Backup and Restore Operations, Backup Topologies, Backup in NAS Environments <b>Textbook1 : Ch.9.1 to 9.6, Ch. 10.1 to 10.9</b> <b>RBT: L1, L2</b>			08
<b>Module 5</b>			
<b>Local Replication:</b> Replication Terminology, Uses of Local Replicas, Replica Consistency , Local Replication Technologies, Tracking Changes to Source and Replica, Restore and Restart Considerations, Creating Multiple Replicas. <b>Remote Replication:</b> Modes of Remote			08

<p>Replication, Remote Replication Technologies. <b>Securing the Storage Infrastructure:</b> Information Security Framework, Risk Triad, Storage Security Domains. Security Implementations in Storage Networking</p> <p><b>Textbook1 : Ch.11.1 to 11.7, Ch. 12.1, 12.2, Ch. 14.1 to 14.4</b></p> <p><b>RBT: L1, L2</b></p>	
<p><b>Course Outcomes:</b> The student will be able to :</p>	
<ul style="list-style-type: none"> <li>• Identify key challenges in managing information and analyze different storage networking technologies and virtualization</li> <li>• Explain components and the implementation of NAS</li> <li>• Describe CAS architecture and types of archives and forms of virtualization</li> <li>• Illustrate the storage infrastructure and management activities</li> </ul>	
<p><b>Question Paper Pattern:</b></p>	
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full Question consisting of 20 marks</li> <li>• There will be 2 full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub questions covering all the topics under a module.</li> <li>• The students will have to answer 5 full questions, selecting one full question from each module.</li> </ul>	
<p><b>Textbooks:</b></p>	
<ol style="list-style-type: none"> <li>1. EMC Education Services, "<b>Information Storage and Management</b>", Wiley India Publications, 2009. ISBN: 9781118094839</li> </ol>	
<p><b>Reference Books:</b></p>	
<ol style="list-style-type: none"> <li>1. Paul Massiglia, Richard Barker, "<b>Storage Area Network Essentials: A Complete Guide to Understanding and Implementating SANs Paperback</b>", 1st Edition, Wiley India Publications, 2008</li> </ol>	

<b>NOSQL DATABASE</b> <b>(Effective from the academic year 2018 -2019)</b> <b>SEMESTER – VIII</b>			
<b>Course Code</b>	<b>18CS823</b>	<b>CIE Marks</b>	40
<b>Number of Contact Hours/Week</b>	3:0:0	<b>SEE Marks</b>	60
<b>Total Number of Contact Hours</b>	40	<b>Exam Hours</b>	03
<b>CREDITS –3</b>			
<b>Course Learning Objectives:</b> This course (18CS823) will enable students to:			
<ul style="list-style-type: none"> <li>• Define, compare and use the four types of NoSQL Databases (Document-oriented, Key-Value Pairs, Column-oriented and Graph).</li> <li>• Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.</li> <li>• Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.</li> </ul>			
<b>Module 1</b>			<b>Contact Hours</b>
Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases. More Details on Data Models; Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modeling for Data Access, <b>Textbook1: Chapter 1,2,3</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 2</b>			
Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums. Version Stamps, Business and System Transactions, Version Stamps on Multiple Nodes <b>Textbook1: Chapter 4,5,6</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 3</b>			
Map-Reduce, Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce Key-Value Databases, What Is a Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multioperation Transactions, Query by Data, Operations by Sets <b>Textbook1: Chapter 7,8</b> <b>RBT: L1, L2, L3</b>			08
<b>Module 4</b>			
Document Databases, What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure <b>Textbook1: Chapter 9</b>			08

<b>RBT: L1, L2, L3</b>	
<b>Module 5</b>	
Graph Databases, What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use. <b>Textbook1: Chapter 11</b> <b>RBT: L1, L2, L3</b>	08
<b>Course Outcomes:</b> The student will be able to :	
<ul style="list-style-type: none"> <li>• Define, compare and use the four types of NoSQL Databases (Document-oriented, Key/Value Pairs, Column-oriented and Graph).</li> <li>• Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.</li> <li>• Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.</li> </ul>	
<b>Question Paper Pattern:</b>	
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full Question consisting of 20 marks</li> <li>• There will be 2 full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub questions covering all the topics under a module.</li> <li>• The students will have to answer 5 full questions, selecting one full question from each module.</li> </ul>	
<b>Textbooks:</b>	
1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addison Wesley, 2012	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN-13: 978-9332557338)</li> <li>2. Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022)</li> <li>3. Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", 2nd Edition, O'Reilly Publications, 2013. (ISBN-13: 978-9351102694)</li> </ol>	



<b>MULTICORE ARCHITECTURE AND PROGRAMMING</b> (Effective from the academic year 2018 -2019) <b>SEMESTER – VII</b>			
<b>Course Code</b>	<b>18CS824</b>	<b>CIE Marks</b>	40
<b>Number of Contact Hours/Week</b>	3:0:0	<b>SEE Marks</b>	60
<b>Total Number of Contact Hours</b>	40	<b>Exam Hours</b>	03
<b>CREDITS –3</b>			
<b>Course Learning Objectives:</b> This course (18CS824) will enable students to:			
<ul style="list-style-type: none"> <li>• Define technologies of multicore architecture and performance measures</li> <li>• Demonstrate problems related to multiprocessing</li> <li>• Illustrate windows threading, posix threads, openmp programming</li> <li>• Analyze the common problems in parallel programming</li> </ul>			
<b>Module -1</b>			<b>Contact Hours</b>
Introduction to Multi-core Architecture Motivation for Concurrency in software, Parallel Computing Platforms, Parallel Computing in Microprocessors, Differentiating Multi-core Architectures from Hyper- Threading Technology, Multi-threading on Single-Core versus Multi-Core Platforms Understanding Performance, Amdahl’s Law, Growing Returns: Gustafson’s Law. System Overview of Threading : Defining Threads, System View of Threads, Threading above the Operating System, Threads inside the OS, Threads inside the Hardware, What Happens When a Thread Is Created, Application Programming Models and Threading, Virtual Environment: VMs and Platforms, Runtime Virtualization, System Virtualization. <b>Textbook 1: Ch.1, 2</b> <b>RBT: L1, L2, L3</b>			08
<b>Module -2</b>			
Fundamental Concepts of Parallel Programming :Designing for Threads, Task Decomposition, Data Decomposition, Data Flow Decomposition, Implications of Different Decompositions, Challenges You’ll Face, Parallel Programming Patterns, A Motivating Problem: Error Diffusion, Analysis of the Error Diffusion Algorithm, An Alternate Approach: Parallel Error Diffusion, Other Alternatives. Threading and Parallel Programming Constructs: Synchronization, Critical Sections, Deadlock, Synchronization Primitives, Semaphores, Locks, Condition Variables, Messages, Flow Control- based Concepts, Fence, Barrier, Implementation-dependent Threading Features <b>Textbook 1: Ch.3, 4</b> <b>RBT: L1, L2, L3</b>			08
<b>Module – 3</b>			
Threading APIs :ThreadingAPIs for Microsoft Windows, Win32/MFC Thread APIs, Threading APIs for Microsoft. NET Framework, Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads, Creating Threads, Managing Threads, Thread Synchronization, Signaling, Compilation and Linking. <b>Textbook 1: Ch.5</b> <b>RBT: L1, L2, L3</b>			08
<b>Module-4</b>			
OpenMP: A Portable Solution for Threading : Challenges in Threading a Loop, Loop-carried Dependence, Data-race Conditions, Managing Shared and Private Data, Loop Scheduling and Portioning, Effective Use of Reductions, Minimizing Threading Overhead, Work-sharing Sections, Performance-oriented Programming, Using Barrier and No wait, Interleaving Single-thread and Multi-thread Execution, Data Copy-in and Copy-out, Protecting Updates of Shared Variables, Intel Task queuing Extension to OpenMP, OpenMP Library Functions,			08

OpenMP Environment Variables, Compilation, Debugging, performance <b>Textbook 1: Ch.6</b> <b>RBT: L1, L2, L3</b>	
<b>Module-5</b>	
Solutions to Common Parallel Programming Problems : Too Many Threads, Data Races, Deadlocks, and Live Locks, Deadlock, Heavily Contended Locks, Priority Inversion, Solutions for Heavily Contended Locks, Non-blocking Algorithms, ABA Problem, Cache Line Ping-ponging, Memory Reclamation Problem, Recommendations, Thread-safe Functions and Libraries, Memory Issues, Bandwidth, Working in the Cache, Memory Contention, Cache-related Issues, False Sharing, Memory Consistency, Current IA-32 Architecture, Itanium Architecture, High-level Languages, Avoiding Pipeline Stalls on IA-32, Data Organization for High Performance. <b>Textbook 1: Ch.7</b> <b>RBT: L1, L2, L3</b>	08
<b>Course Outcomes:</b> The student will be able to :	
<ul style="list-style-type: none"> <li>• Identify the limitations of ILP and the need for multicore architectures</li> <li>• Define fundamental concepts of parallel programming and its design issues</li> <li>• Solve the issues related to multiprocessing and suggest solutions</li> <li>• Make out the salient features of different multicore architectures and how they exploit parallelism</li> <li>• Demonstrate the role of OpenMP and programming concept</li> </ul>	
<b>Question Paper Pattern:</b>	
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full Question consisting of 20 marks</li> <li>• There will be 2 full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub questions covering all the topics under a module.</li> <li>• The students will have to answer 5 full questions, selecting one full question from each module.</li> </ul>	
<b>Textbooks:</b>	
1. Multicore Programming , Increased Performance through Software Multi-threading by Shameem Akhter and Jason Roberts , Intel Press , 2006	
<b>Reference Books:</b>	
<ol style="list-style-type: none"> <li>1. Yan Solihin, "Fundamentals of Parallel Multicore Architecture", 1st Edition, CRC Press/Taylor and Francis, 2015.</li> <li>2. GerassimosBarlas, "Multicore and GPU Programming: An Integrated Approach Paperback", 1st Edition, Morgan Kaufmann, 2014.</li> <li>3. Lyla B Das, "The x86 Microprocessors: 8086 to Pentium, Multicores, Atom and the 8051 Microcontroller: Architecture, Programming and Interfacing", 2nd Edition, Pearson Education India, 2014</li> </ol>	