ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Computer Sciences
Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (CSE) 21/ 23/…/ 39: Odd Sem. (IT) 41/ 43/…/ 59: Odd Sem. (MCA) 61/ 63/…/ 79: Odd Sem. (Prog-4) 81/ 83/…/ 99: Odd Sem. (Prog-5) 02/ 04/…/ 20: Even Sem. (CSE) 22/ 24/…/ 40: Even Sem. (IT) 42/ 44/…/ 60: Even Sem. (MCA) 62/ 64/…/ 80: Even Sem. (Prog-4) 82/ 84/…/ 98: Even Sem. (Prog-5)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	CS6101	Advanced Data Structures and Algorithms	3	0	0	3	40	60	-	100
2	PC 2	CS6103	Wireless Sensor Networks	3	0	0	3	40	60	-	100
3	PE 1 (Any One)	CS6201	Internet of Things	3	0	0	3	40	60	-	100
		CS6203	Cryptography								
4		CS6205	Data Mining								
	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
5	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
6	LC 1	CS6501	Advanced Data Structures and Algorithms Lab	0	0	4	2	-	-	100	100
7	LC 2	CS6503	Computing Lab - I	0	0	4	2	-	-	100	100
8	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**16**	**0**	**8**	**18**	**240**	**360**	**200**	**800**

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2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	CS6102	High Performance Computing	3	0	0	3	40	60	-	100
2	PC 4	CS6104	Object Oriented Analysis and Design	3	0	0	3	40	60	-	100
3	PE 2 (Any One)	CS6202	Machine Learning Applications	3	0	0	3	40	60	-	100
		CS6204	Computer Graphics								
		CS6206	Mobile Computing								
4	PE 3 (Any One)	CS6208	Computer Vision	3	0	0	3	40	60	-	100
		CS6210	Cloud Computing								
		CS6212	Digital Forensics								
5	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
6	PR 1	CS6602	Project (Specialization Related)	0	0	4	2	-	-	100	100
7	LC 3	CS6502	Computing Lab - II	0	0	4	2	-	-	100	100
8	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**17**	**0**	**8**	**19**	**240**	**360**	**200**	**800**

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE 4* (Any One)	CS7201	Software Testing	3	0	0	3	40	60	-	100
		CS7203	Human Computer Interaction								
		CS7205	Real Time Systems								
2	PR 2	CS7601	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**3**	**0**	**24**	**15**	**40**	**60**	**100**	**200**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	CS7602	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	18	800
2	2nd	19	800
3	3rd	15	200
4	4th	16	100
Total		68	1900

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1st Semester

PC 1	CS6101	Advanced Data Structures and Algorithms	3	0	0	3

Course Outcomes:

1. Understand basic data structures and its complexity analysis, ability to use asymptotic notations, solve recurrences, and perform algorithm analysis and its correctness.
2. Ability to design, analyze based on search structure, heap structures, multimedia structure and graph algorithm.
3. Have an idea of applications of algorithms in a variety of areas, including string matching and approximation algorithm.

Module-I:

Elementary Data Structures and Complexity Analysis: Overview of Basic Data Structures: Arrays, Linked List, Stack, Queues. Implementation of Sparse Matrices, Algorithm Complexity: asymptotic analysis, Simple Recurrence Relations and use in algorithm analysis, amortized analysis.

Module-II:

Search Structures: Height Balanced Trees: AVL trees, 2-3 trees, Red-black trees, B-trees, B^+-trees.
Heap Structures: Min-max heaps, Binomial heaps, Fibonacci heaps
Multimedia Structures: Segment trees, k-d trees, Point Quad trees
Graph Algorithms: Single-source shortest path Algorithms, All-pairs shortest path algorithms including Johnson Algorithm, Strongly Connected Components, Articulation Points, Topological sort
Minimum spanning tree algorithm using Boruvka steps

Module-III:

String Matching Algorithms: Introduction, The Brute-Force- Algorithm, Rabin-Karp Algorithm, String Matching with Finite automata, Knuth-Marries-Pratt Algorithm, Robin Karp algorithm
Approximation Algorithms: Travelling Salesperson Problem, Vertex-Cover Problem and Set-Cover Problem

Text Book:

1.Thomas Cormen, Charles Leiserson, Ronald Rivest and Clifford Stein, *Introduction to Algorithms*, MIT Press, 2009 (third edition).

Reference Books:

1.S. Dasgupta, C.H. Papadimitriou, and U.V. Vazirani, *Algorithms*, Mcgraw-Hill, 2006.
2.J. Kleinberg and E. Tardos, *Algorithm Design*, Addison-Wesley, 2006.
3.G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Printice –Hall, 1988.

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PC 2	CS6103	Wireless Sensor Networks	3	0	0	3

Course Outcomes

1. Understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology.
2. Analyze key routing protocols for sensor networks and main design issues.
3. Learn transport layer protocols for sensor networks, and design requirements
4. Understand the Sensor management, sensor network middleware, operating systems

Module I

Introduction: Introduction to Wireless Sensor Networks, Node architecture, Operating System, Advantages of Sensor Networks, Application of Sensor Networks, Challenges and Constraints.

Network deployment: Structured vs randomized deployment, Network topology, Connectivity in geometric random graphs, Connectivity using power control, Coverage metrics, Mobile deployment.

Localization: issues & approaches, Coarse-grained & Fine-grained node localization, Network-wide localization, Theoretical analysis of localization techniques.

Module II

Synchronization: Issues & Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization.

Wireless characteristics: Basics, Wireless link quality, Radio energy considerations, SINR capture model for interference.

Medium-access and sleep scheduling: Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols. Sleep-based topology control: Constructing topologies for connectivity, constructing topologies for coverage

Module III

Routing: Metric-based approaches, Routing with diversity, Multi-path routing, Lifetime- maximizing energy-aware routing techniques, Geographic routing, Routing to mobile sinks.

Data-centric networking: Data-centric routing, Data- gathering with compression, Querying, Data-centric storage and retrieval, The database perspective on sensor networks. Introduction to Tiny OS, NesC, Sensor Simulator.

Security: Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks.

REFERENCE BOOKS:

1. Wireless Sensor Networks: Technology, Protocols, and Applications: KazemSohraby, Daniel Minoli, TaiebZnati , Wiley Inter Science.
2. Wireless Sensor Networks: Architectures and Protocols: Edgar H. Callaway, Jr. Auerbach Publications, CRC Press.
3. Wireless Sensor Networks: Edited by C.S Raghavendra, Krishna M, Sivalingam, TaiebZnati , Springer.
4. Networking Wireless Sensors: BhaskarKrismachari, Cambridge University Press
5. Distributed Sensor Networks: A Multiagent Perspective, Victor Lesser, Charles L. Ortiz, and MilindTambe , Kluwer Publications.
6. Wireless Sensor Networks: An Information Processing Approach- by Feng Zhao, Leonidas Guibas , Morgan Kaufmann Series in Networking 2004

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PE 1	CS6201	Internet of Things	3	0	0	3

Course Outcomes:

1. Upon completion of this course, students will acquire knowledge about:
2. Design a portable IoT using Arduino/ equivalent boards and relevant protocols.
3. Develop web services to access/control IoT devices.
4. Analyze applications of IoT in real time scenario and deploy an IoT application and connect to the cloud.

Module-I:

What is the Internet of Things? : History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations, Working Definition, IoT Frameworks

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 Introduction, M2M-Difference between IoT and M2M.

Module-II:

RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPC Global Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things.

Wireless Sensor Networks: History and context, WSN Architecture, the node, connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches, Data link layer protocols, routing protocols and infrastructure establishment.

Clustering, Software Agents, Clustering Principles in an Internet of Things Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization.

Module-III:

Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT.

Business Models and Business Model Innovation, Value Creation in the Internet of Things, Business Model Scenarios for the Internet of Things. Internet of Things Application: Smart Metering Advanced Metering Infrastructure, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Low-power design (Bluetooth Low Energy),

Text Books

1. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World ofM2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications
2. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
3. Parikshit N. Mahalle& Poonam N. Railkar, “Identity Management for Internet of Things”, River
4. Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

Reference Books

1. HakimaChaouchi, “The Internet of Things Connecting Objects to the Web” ISBN: 978-1-84821-140-7, Willy Publications
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications andProtocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
3. Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”,.Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978-0989973700.
4. Fang Zhaho, Leonidas Guibas, “Wireless Sensor Network: An information processing approach”, Elsevier, ISBN: 978-81-8147-642-5.

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PE 1	CS6203	Cryptography	3	0	0	3

Course Outcomes:

The student who successfully completes this course will be able to:

1. Analyze and design classical encryption techniques and block ciphers.
2. Understand and analyze data encryption standard. Understand and analyze public-key cryptography, RSA and other public-key cryptosystems such as Diffie-Hellman Key Exchange, Elgamal Cryptosystem, etc.
3. Understand key management and distribution schemes and design User Authentication Protocols.
4. Analyze and design hash and MAC algorithms, and digital signatures.
5. Design network application security schemes, such as PGP, S/ MIME, IPSec, SSL, TLS, HTTPS, SSH, etc. and know about Intruders and Intruder Detection mechanisms, Types of Malicious software, Firewall Characteristics, Types of Firewalls, Firewall Location and Configurations.

Module-I:

Algebra: Group, cyclic group, cyclic subgroup, field, probability. Number Theory: Fermat's theorem, Cauchy's theorem, Chinese remainder theorem, primality testing algorithm, Euclid's algorithm for integers, quadratic residues, Legendre symbol, Jacobi symbol etc.

Module-II:

Cryptography and cryptanalysis, Classical Cryptography, substitution cipher, different type of attack: CMA, CPA, CCA etc, Shannon perfect secrecy, OTP, Pseudo random bit generators, stream ciphers and RC4.

Module-III:

Block ciphers: Modes of operation, DES and its variants, AES, linear and differential cryptanalysis.

One-way function, trapdoor one-way function, Public key cryptography, RSA cryptosystem, Diffie Hellman key exchange algorithm, Elgamal Cryptosystem.

Cryptographic hash functions, secure hash algorithm, Message authentication, digital signature, RSA, digital signature, Elgamal digital signature.

Textbook:

1. W. Stallings, Cryptography and Network Security Principles and practice, 5/e, Pearson Education Asia, 2012.

2. Behrouz A.Forouzan and DebdeepMukhopadhyay, Cryptography and Network Security, second edition, Tata McGraw Hill, 2011

Reference Books:

1. Thomas Koshy, Elementary Number Theory with applications, Elsevier India, 2005.
2. Stinson. D. Cryptography: Theory and Practice, third edition, Chapman & Hall/CRC, 2010.

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PE 1	CS6205	Data Mining	3	0	0	3

COURSE OBJECTIVE:

1. Be familiar with mathematical foundations of data mining tools.
2. Understand and implement classical models and algorithms in data warehouses and data mining
3. Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering**.**

Course Outcomes:

1. Understand the functionality of the various data mining and data warehousing component
2. Design Multidimensional data model for data warehouse and analyze the market needs by applying suitable OLAP operations.
3. Explain the concept of Data mining system and apply the various pre-processing techniques on large dataset.
4. Apply Association rules, classification and clustering techniques to discover various mining techniques.
5. Explore recent trends in data mining such as web mining, spatial-temporal mining.

Module-I:

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems-Classification Of Data Mining Systems.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Module-II:

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Module-III:

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Mining Object, Spatial, Multimedia, Text and Web Data:

Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Text Book

1. Jiawei Han, MichelineKamber and Jian Pei"Data Mining Concepts and Techniques", ThirdEdition, Elsevier, 2011.

Reference Books

1 Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw –Hill Edition, Tenth Reprint 2007.

2 K.P. Soman, ShyamDiwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.

3 G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.

4 Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

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MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

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LC 1	CS6501	Advanced Data Structures and Algorithms Lab	0	0	4	2

List of Experiments

1. Implementation of Sparse Matrices.
2. Implementation of Binary search trees.
3. Implementation of AVL-trees, insertion and deletion into AVL trees.
4. Implementation of Red – Black trees.
5. Implementation of B-trees
6. Implementation of Priority queues
7. Implementation of Heaps: Min-max Heap, Binomial and Fibonacci Heaps.
8. Implementation of Graph Traversals: BFS and DFS.
9. Implementation of Shortest Path Problems: Dijkastra's Algorithm
10. Implementation of All Pair Shortest Path: Floyd-Warshall~~'s~~ algorithm
11. Implementation of Minimum Spanning tree :Kruskal's Algorithm, Prim's Algorithm
12. Implementation of String Matching Algorithms: KMP only

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LC 2	CS6503	Computing Lab - I	0	0	4	2

Experiment 1 Analyzing Number of Transmitting Nodes Vs Collision count, Mean Delay for an Ethernet LAN.

Experiment 2 Analyzing Bus Vs Star topology with respect to number of collisions (for a fixed number of transmitting nodes) for Ethernet LAN.

Experiment 3 Analyzing the difference between Hub vs Switch transmission with respect to throughput and delay.

Experiment 4 Analyzing the performance of Token Ring with Number of Nodes vs Response Time, Mean Delay using NETSIM.

Experiment 5 Comparing CSMA/CA vs CSMA/CD protocol with respect to throughput and collision count (for a fixed number of transmitting nodes).

Experiment 6 a) Verification of Stop and Wait Protocol.
b) Verification of Go Back N Protocol.
c)Verification of Selective Repeat Protocol.

Experiment 7 Matlab basics and elementary calculations.

Experiment 8 Implementation of various matrix operations using Matlab:
a) Matrix addition
b) Matrix subtraction
c) Matrix multiplication
d) Transpose of a matrix
e) Inverse of a matrix.

Experiment 9 Built in Function for matrix operation using Matlab.

Experiment 10 Plotting graphs in 2D and 3D IN line graph, bar graph and pie chart using Matlab.

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AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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2nd Semester

PC 3	CS6102	High Performance Computing	3	0	0	3

Course Outcomes:

On successful completion of the course, the student will be having the basic knowledge of computing technology.

1. Student will be able to understand pipelining and hazards.
2. Student will be able to know array processors.
3. Know about instruction level parallelism.
4. Student will be able to know multiprocessor architecture. Students will know different parallel memory organizations and their issues.

Module-I:

Introduction: review of basic computer architecture, quantitative techniques in computer design,measuring and reporting performance. CISC and RISC processors. Pipelining: Basic concepts,instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards.

Module-II:

Array processors: SIMD array processor, SIMD computer organization, SIMD Interconnection network. Vector processor, characteristics.

Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures.

Module-III:

Multiprocessor architecture: functional structures: UMA, NUMA, Distributed Memory architectures, Loosely Coupled & Tightly Coupled Multiprocessor, Processor characteristics of multiprocessor, Interconnection networks. Parallel memory organizations: Interleaved memory, L-M organization, cache coherence.

Reference Books:

1. Computer Architecture & Parallel Processing. Kai Hwang & Briggs, McGraw-Hill.
2. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach,
Morgan Kaufmann.
3. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill.
4. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House.

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PC 4	CS6104	Object Oriented Analysis and Design	3	0	0	3

Course Outcomes:

1. Understand the basics object model for System development and object-Oriented Methodologies
2. Demonstrate software design with UML diagrams
3. Understand the concept of Relationships
4. Design software applications using OO concepts.
5. Analyze various testing methodologies for OO software and compare and contrast various testing techniques

Module-I:

Introduction: Overview Of OOL; Object Oriented Concepts, Object Oriented System Development Lifecycle, Object Oriented Methodologies; The Unified Approach

Unified Modeling Language: Overview of Unified Modeling Language (UML), Static and Dynamic Models, UML Diagrams, UML Class Diagrams, Use-Case Diagrams, UML Dynamic Modeling, Implementation diagrams, Model Management: Package and Model Organization, UML Extensibility, UML Meta-Model.

Module-II:

Object Oriented Analysis – Identifying Use-Cases: Complexity in Object Oriented Analysis, Business Process Modeling and Business Object Analysis, Use-Case Driven Object Oriented Analysis, Use-Case Model, Developing Efficient Documentation.

Object Analysis: Classification: Object Analysis, Classification Theory, Approaches for Identifying Classes, Class Responsibility Collaboration.

Object Oriented Analysis – Identifying Relationships, Attributes, and Methods: Introduction, Associations, Inheritance Relationships, A Part of Relationship-Aggregation, Class Responsibility: Identifying Attributes and Methods, Class Responsibility: Defining Attributes, Object Responsibility: Methods and Messages.

Object Oriented Design Process and Design Axioms: Design Process, Design Axioms, Corollaries, Design Patterns.

Designing Classes: The Object Oriented Design Principles, UML Object Constraint Language (OCL), Strategies for Designing Classes, Class Visibility: Designing Public Private and Protected Protocols, Designing Classes: Refining Attributes, Designing Methods and Protocols, Packages and Managing Classes.

Module-III:

Access Layer: Object Store and Persistence, Database Management Systems, Logical and Physical Database Organization and Access Control, Object Oriented Database Management Systems (OODBMS), Object Relational Systems, Designing Access Layer Classes.

View Layer: User Interface Design as a Creative Process, Designing View Layer Classes, Purpose of a View Layer Interface, Prototyping the User Interface.

Software Quality Assurance: Quality Assurance Tests, Software Testing Techniques, Testing Strategies, Impact of Object Orientation on Testing, Test Cases, Test Plan, Myer's Debugging Principles.

System Usability and Measuring User Satisfaction: Usability Testing, User Satisfaction Test, Analyzing User Satisfaction by Satisfaction Test Template, Developing Usability Test Plans and Test Cases.

Text/References:

1. Ali Bahrami, "Object Oriented System Development", McGraw Hill, 1999.
2. Grady Booch, J. Rambaugh and Ivar Jacobson, "The UML Users guide", Addison-Wesely, 2/e, 2005.
3. J. Rambaugh and M. R. Blaha, "Object Oriented Modeling and Design", Prentice Hall, 2/e, 2004.
4. Andrew Haigh, "Object Oriented Analysis and Design", Tata McGrawHill, 2001.
5. Stephen R. Schach, "Object Oriented and Classical Software Engineering", 8/e, 2010.

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Syllabus (Effective from 2023-24)

School/ Department: School of Computer Sciences
Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 2	CS6202	Machine Learning Applications	3	0	0	3

Course Outcomes:

1. Learn the basics of learning problems with hypothesis and version spaces
2. Understand the features of machine learning to apply on real world problems
3. Analyze the concept of neural networks for learning linear and non-linear activation functions
4. Learn the concepts in Bayesian analysis from probability models and methods
5. Understand the fundamental concepts of NLP, Data mining, HCI with application

Module-I:

Introduction to Machine learning system: Types of learning, Algorithmic models of learning, Classification, Regression, hypothesis space and inductive bias, Evaluation.

Basic Mathematical and Statistical concepts: Metric, Matrices, Eigen values and Eigen vectors, mean, median, mode, variance, co-variance, correlation, Binomial distribution and normal distribution, Basic concepts in probabilistic models such as Bayes theorem, Bayesian, maximum a posteriori and minimum description length frameworks.

Module-II:

Algorithm models of learning, Learning classifiers**,** Linear, Nonlinear, Multiple and logistic Regression, Linear Discriminant Analysis (LDA), Decision trees, K-mean and Hierarchical clustering, Support Vector Machine (SVM), Bayesian networks, Markov and Hidden Markov models, k-nearest neighbor classifiers,

Module-III:

Neural networks: Perceptron, Multilayer Artificial Neural Network, Back Propagation Learning Algorithm, Radial Basis Network, Applications on ANN.

Computational learning theory, mistake bound analysis, Occam learning, accuracy and confidence boosting. Dimensionality reduction, Principal Component Analysis (PCA), feature selection and visualization.

Reinforcement learning, learning from heterogeneous, distributed data and knowledge. Selected applications in data mining, automated knowledge acquisition, pattern recognition, text and language processing, human-computer interaction.

Text Book:

1. Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag
2. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
3. EthemAlpaydin, Introduction to Machine Learning, MIT Press (MA), 2004.

Reference Books:

1. Baldi, P. and Brunak, S. (2002). Bioinformatics: A Machine Learning Approach. Cambridge, MA: MIT Press.
2. Baldi, P., Frasconi, P., Smyth, P. (2003). Modeling the Internet and the Web - Probabilistic Methods and Algorithms. New York: Wiley.
3. Bishop, C. M. Neural Networks for Pattern Recognition. New York: OxfordUniversity Press (1995).
4. Chakrabarti, S. (2003). Mining the Web, Morgan Kaufmann.
5. Cohen, P.R. (1995) Empirical Methods in Artificial Intelligence. Cambridge, MA: MIT Press.
6. Cowell, R.G., Dawid, A.P., Lauritzen, S.L., and Spiegel halter, D.J. (1999). Graphical Models and Expert Systems.Berlin: Springer.
7. Cristianini, N. and Shawe-Taylor, J. (2000). An Introduction to Support Vector Machines. London: Cambridge University Press.Duda, R., Hart, P., and Stork, D. (2001). Pattern Classification. New York: Wiley.

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 2	CS6204	Computer Graphics	3	0	0	3

COURSE OUTCOMES:

1. *Students will be able to describe the fundamental algorithms used in computer graphics and to some extent be able to compare and evaluate them.*
2. *Students will be able to work and interact, through hands-on experiences, to design, develop, and modify electronically generated imaginary using a wide range of sophisticated graphical tools and techniques.*
3. *Students will be able to summarize different hidden surface elimination algorithms and shading techniques used in computer graphics and digital media production.*
4. *Students will be able to explain about the technology necessary for creating multimedia content for the web, video, DVD, 2D and 3D graphics, Sound and programming.*
5. *Students can apply the knowledge, techniques, skills and modern tools to become successful professionals in communication and media industries*

Module – I

Three Dimensional Geometric and Modeling Transformations: Translation, Rotation, Scaling,
Reflections, shear, Composite Transformation. Projections: Parallel Projection, Perspective Projection. ellipse

Module – II

Two Dimensional Object Representations: Spline Representation, Bezier Curves, B-Spline Curves.
Fractal Geometry: Fractal Classification and Fractal Dimension, inverse problem in fractals
Wireframe model, surface rendering, 3-D modeling
Virtual Reality: VR, augmented reality, hardware and software for VR, senses to recognize a VR system

Module – III

Illumination Models: Basic Models, Displaying Light Intensities.
Computer Animation: Types of Animation, Key frame Vs. Procedural Animation, Methods of
Controlling Animation, Morphing.

Textbook:

1. Computer Graphics Principle and Practice, J.D. Foley, A. Dam, S.K. Feiner, Addison Wesley.
2. Procedural Elements of Computer Graphics, David Rogers, TMH.

Reference Books:

1. Computer Graphics: Algorithms and Implementations, D.P Mukherjee, D. Jana, PHI.
2. Computer Graphics, Z. Xiang, R. A. Plastock, Schaum's Outlines, McGrow Hill.
3. Computer Graphics, S. Bhattacharya, Oxford University Press.

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Duration: 2 years (Four Semesters)

PE 2	CS6206	Mobile Computing	3	0	0	3

Course Outcomes

1. Explain the basic concepts of wireless network and wireless generations.
2. Demonstrate the different wireless technologies such as CDMA, GSM, GPRS etc
3. Describe and judge the emerging wireless technologies standards such as WLL, WLAN, WPAN, WMAN.
4. Explain the design considerations for deploying the wireless network infrastructure.

Module – I:

Introduction: Three Tier Architecture Mobile Computing Architecture, Evolution of Wireless Technology
Wireless Transmission: Signal, Antenna, Signal Propagation, Multiplexing, Modulation, Spread Spectrum
Cellular System: Cell, Cluster, Cell Splitting, Frequency Reuse, Frequency Management, Channel Assignment Strategies, Components of Cellular System, Operation of Cellular System

Module – II:

Global System for Mobile Communication (GSM): Overview, Architecture, Addresses and identifiers, Network signaling, Radio interfaces, Channels, Mobility Management.
General Packet Radio Services (GPRS): Architecture, GPRS Interfaces, Network Protocols, GPRS Handsets
Wireless LAN (WLAN): Application, Requirement, IEEE 802.11(Ad-hoc Mode, Infrastructure Mode, Protocol Architecture), Bluetooth (Piconet, Scatternet, Protocol Stack, Bluetooth Profile)
Mobile Ad-Hoc Network: Types, Topology, Applications, Proactive Routing (DSDV, OLSR), Reactive Routing (AODV, DSR), Hybrid Routing (ZRP)

Module – III:

Wireless Application Protocol (WAP): WAP Gateway and Protocols, Wireless Markup Languages (WML)
Mobile IP: Terminology, Operations, Location Management, Mobility Management
IMT 2000: Vision, IMT-2000 Family, UMTS (Architecture, Interfaces)
Emerging Technologies: WiFi, WiMax, LTE

Text Books:

1. Mobile Communication: J. Schiller, 2ND Edition, Pearson Education
2. Mobile Computing: AsokeTalukdar, 2nd Edition, TMH.

Reference Books:

1. Mobile Computing: P.K. Patra, S.K. Dash, 2nd Edition, Scitech Publications.
2. Fundamentals of Mobile Computing, Prashanta Kumar Patnaik and Rajib Mall, PHI, 2nd Edition, 2015
3. Mobile Computing, Raj Kamal, 2nd Edition, Oxford University Press
4. Wireless Communications, T.L. Singhal, TMH

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Duration: 2 years (Four Semesters)

PE 3	CS6208	Computer Vision	3	0	0	3

Course Outcomes:

After completing the course, you will be able to:

1. identify basic concepts, terminology, theories, models and methods in the field of computer vision, · describe known principles of human visual system,
2. Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition,
3. Suggest a design of a computer vision system for a specific problem

Module1:

Digital Image Formation and low-level processing

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Depth estimation and Multi-camera views

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. apparel

Module2:

Feature Extraction

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Module3:

Pattern Analysis Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Shape from X Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Textbooks

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

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School/ Department: School of Computer Sciences
Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 3	CS6210	Cloud Computing	3	0	0	3

Course Outcomes:

At the end of this course student will:

6. Understand the concept of virtualization and how this has enabled the development of Cloud Computing
7. Know the fundamentals of cloud, cloud Architectures and types of services in cloud
8. Understand scaling, cloud security and disaster management
5. Design different Applications in cloud
6. Explore some important cloud computing driven commercial systems

Module-I:

Introduction: Cloud-definition, benefits, usage scenarios, History of Cloud Computing – Cloud Architecture – Types of Clouds – Business models around Clouds – Major Players in Cloud Computing – issues in Clouds – Eucalyptus – Nimbus – Open Nebula, CloudSim, Risks Involved in Cloud Computing. **Cloud Services:** Types of Cloud services: Software as a service – Platform as a Service – Infrastructure as a Service – database as a Service – Monitoring as a Service – Communication as services, Service providers – Google, Amazon, Microsoft Azure, IBM, Salesforce.

Module-II:

Collaborating Using Cloud Services: Email Communication over the Cloud – CRM Management – Project Management – Event Management – Task Management – Calendar – Schedules – Word Processing – Presentation – Spreadsheet – Databases – Desktop – Social Networks and Groupware, Work Loan Management in Cloud. **Virtualization For Cloud:** Need for Virtualization – Pros and cons of Virtualization – Types of Virtualization – System Vm, Process VM, Virtual Machine monitor – Virtual machine properties – Interpretation and binary translation, HLL VM – Hypervisors – Xen, KVM, VMWare, Virtual Box, Hyper-V.

Module-III:

Data & Cloud Storage: Enterprise Data Storage (SAN, NAS), Cloud File System, Cloud Data stores & Data management for cloud storage.

Other Ways to Collaborate Online: Collaborating via Web – Based Communication Tools – Evaluating Web Mail Services – Evaluating Web Conference Tools – Collaborating via Social Networks and Groupware – Collaborating via Blogs and Wikis.

Security, Standards and Applications: Security in Cloud: Cloud security challenges – Software as a Service Security, Common Standards: The Open Cloud Consortium – The Distributed Management Task Force – Standards for application Developer – Standards for Messaging – Standards for Security, End user access to cloud computing, Mobile Internet devices and the cloud.

Text/ References:

1. John Rittinghouse and James Ransome, “Cloud Computing, Implementation, Management andStrategy”, CRC Press, 2009.
2. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate”, Que Publishing, August 2008.
3. James E Smith and Ravi Nair, “Virtual Machines”, Morgan Kaufmann, 2006.
4. David E. Y. Sarna, “Implementing and Developing Cloud Application”, CRC press 2011.
5. Lee Badger, Tim Grance, Robert Patt-Corner and Jeff Voas, NIST Draft cloud computing synopsis and recommendation, 2011.
6. Anthony T Velte, Toby J Velte and Robert Elsenpeter, “Cloud Computing: A Practical Approach”, Tata McGraw-Hill, 2009.

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School/ Department: School of Computer Sciences
Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 3	CS6212	Digital Forensics	3	0	0	3

Course Outcomes:

Students will be able to learn

1. Fundamentals of forensics, benefits, legal issues.
2. How to perform hi-tec investigations
3. Different data acquisition formats & methods
4. Activities related to crimes and incident scenes
5. Learn different computer forensic tools and software
6. Performing E-mail investigations

Module-I:

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues

Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

Module-II:

Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case

Module-III:

Current computer forensics tools- software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

Text Books:

1. Warren G.Kruse II andJay G. Heiser**, "**Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C**.**, **"**Guide to Computer Forensics andInvestigations, 2nd**e**d**.**, Thomson Course Technology, 2006, ISBN: 0-619-21706-5.

Reference Books:

1. Vacca, J, *Computer Forensics, Computer Crime Scene Investigation*, 2nd Ed, CharlesRiver Media, 2005, ISBN: 1-58450-389.

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: School of Computer Sciences
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PR 1	CS6602	Project (Specialization Related)	0	0	4	2

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

LC 3	CS6502	Computing Lab - II	0	0	4	2

List of Experiments

1. Write a Python program to print your name and registration number.
2. Devise a Python program to implement arithmetic operations.
3. Write a Python program to demonstrate use of conditional statements.
4. Devise a Python program to illustrate loop statements.
5. Write a Python program to exhibit function components.
6. Write a Python program to demonstrate use of string manipulations.
7. Display recursion of a function using a Python program.
8. Create a list using a Python program for a given problem.
9. Construct a dictionary using a Python program for a given problem.
10. Demonstrate use of file operations using a Python program.

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

3rd Semester

PE 4	CS7201	Software Testing	3	0	0	3

Course Outcomes:

1. Analyze requirements to determine appropriate testing strategies.
2. Apply a wide variety of testing techniques in an effective and efficient manner.
3. Compute test coverage and yield according to a variety of criteria.
4. Evaluate the limitations of a given testing process and provide a succinct summary of those limitations.
5. Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.
6. Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods
7. Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problems
8. Have an ability to use software testing methods and modern software testing tools for their testing projects.

Module-I:

INTRODUCTION: Testing as an Engineering Activity–Testing as a Process– Testing axioms–Basic definition– Software Testing Principles–The Tester's Role in a Software Development Organization–Origins of Defects–Cost of defects–Defect Classes–The Defect Repository and Test Design–Defect Examples–Developer/Tester Support of Developing a Defect Repository –Defect Prevention strategies.

TESTCASEDESIGN: Test case Design Strategies– Using Black Bod Approach to Test Case Design– Random Testing– Requirements based testing–Boundary Value Analysis–Equivalence Class Partitioning–State- based testing–Cause-effect graphing–Compatibility testing–user documentation testing–domain testing–Using WhiteBoxApproachtoTestdesign– TestAdequacyCriteria–statictestingvs. Structural testing–code functional testing–Coverage and Control Flow Graphs– Covering Code Logic– Paths–code complexity testing–Evaluating Test Adequacy Criteria.

Module-II:

LEVELSOFTESTING: The need for Levers of Testing–Unit Test –Unit Test Planning–Designing the Unit Tests–The Test Harness– Running the Unit tests and Recording results– Integration tests– Designing Integration Tests–Integration Test Planning–Scenario testing–Defect bash elimination

System Testing– Acceptance testing– Performance testing– Regression Testing– Inter nationalization testing– Ad-hoc testing–Alpha, Beta Tests–Testing OO systems–Usability and Accessibility testing–Configuration testing–Compatibility testing–Testing the documentation–Web site testing.

Module-III:

TESTMANAGEMENT: People and organizational issues in testing– Organization structures for testing teams– testing services– Test Planning – Test Plan Components– Test Plan Attachments– Locating Test Items– test management–test process–Reporting Test Results– The role of three groups in Test Planning and Policy Development–Introducing the test specialist–Skills needed by a test specialist–Building a Testing Group.

TEST AUTOMATION: Software test automation – skill needed for automation – scope of automation – design and architecture for automation–requirements for test tool–challenges in automation–Test metrics and measurements –project, progress and productivity metrics.

TEXTBOOKS:

1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing–Principles and Practices", PearsonEducation,2006.
2. RonPatton, "Software Testing", Second Edition, Sams Publishing, Pearson Education, 2007.

REFERENCES:

1. Ilene Burnstein, "Practical Software Testing", Springer International Edition, 2003.
2. Edward Kit," Software Testing in the Real World – Improving the Process", Pearson Education, 1995.
3. Boris Beizer," Software Testing Techniques" – 2 nd Edition, Van Nostrand Reinhold, New York, 1990.
4. Aditya P. Mathur, "Foundations of Software Testing _ Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008.

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 4	CS7203	Human Computer Interaction	3	0	0	3

Students will learn

1. Human I/O Channels
2. Interaction model frameworks
3. Cognitive models
4. Mobile systems application frameworks
5. Designing web interfaces

Module-I

The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms. Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Module-II

Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW. Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Module-III

Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.

TEXT BOOKS:

- Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, 3rd Edition, Pearson Education, 2004 (UNIT I, II & III)
- Brian Fling, “Mobile Design and Development”, First Edition, O’Reilly Media Inc., 2009
- Bill Scott and Theresa Neil, “Designing Web Interfaces”, First Edition, O’Reilly, 2009.

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PE 4	CS7205	Real Time Systems	3	0	0	3

Course Outcomes:

1: To study the basic of tasks and scheduling.
2: To understand programming languages and databases.
3: To analyze real time communication.
4: To analyze evaluation techniques and reliability models for Hardware Redundancy.
5: To understand clock synchronization.

Module-I:

Introduction to real time computing - Concepts; Example of real-time applications – Structure of a real time system – Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time: Source code analysis, Micro-architecture level analysis, Cache and pipeline issues- Programming Languages for Real-Time Systems

Module-II:

Real time OS – Threads and Tasks – Structure of Microkernel – Time services – Scheduling Mechanisms Communication and Synchronization – Event Notification and Software Interrupt Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms-Fault tolerant scheduling.

Module-III:

Real Time Communication -Network topologies and architecture issues – protocols – contention based, token based, polled bus, deadline-based protocol, Fault tolerant routing. RTP and RTCP.
Real time Databases – Transaction priorities – Concurrency control issues – Disk scheduling algorithms – Two phase approach to improve predictability.

Text Book

1. C.M. Krishna, Kang G. Shin – “Real Time Systems”, International Edition, McGraw HillCompanies, Inc., New York, 1997

Reference Books

1. Jane W.S. Liu, Real-Time Systems, Pearson Education India, 2000.
2. Philip A. Laplante and Seppo J. Ovaska, “Real-Time Systems Design and Analysis: Toolsfor the Practitioner’’ IV Edition IEEE Press, Wiley. 2011

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

PR 2	CS7601	Dissertation (Phase-I)	0	0	24	12

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Course: M. Tech. (SSP), Programme: Computer Science and Engineering (CSE),
Duration: 2 years (Four Semesters)

4th Semester

PR 3	CS7602	Dissertation (Phase-II)	0	0	32	16