UNIVERSITY OF KERALA

SCHEME & SYLLABUS
for
M-Tech Degree Programme
in
Computer Science & Engineering
(2013 Scheme)

University of Kerala

Scheme of Studies for Master of Technology

Stream : *Computer Science & Engineering*

Semester 1

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam (Hours)	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
RCC 1001	Mathematical Foundations of Computer Science	3	3	3	40	60	100	End-of-Semester Exam by University
RIC 1001	Foundations of Information Security	3	3	3	40	60	100	-do-
RCC 1002	Topics in Database Technology	3	3	3	40	60	100	-do-
RCC 1003	Advanced Data Structures and Algorithms	3	3	3	40	60	100	-do-
RCC 1004	Advanced Software Engineering	3	3	3	40	60	100	-do-
RCC 1005	Advanced Computer Architecture	3	3	3	40	60	100	-do-
RCC 1101	Seminar	2	2	-	100	-	100	No End-of-sem Exam
RCC 1102	Algorithm Design Laboratory	1	2	-	100	-	100	-do-
	TOTAL	**21**	**22**	**18**	**440**	**360**	**800**	

Note: - Out of 40 marks of Internal Continuous Assessment, 25 marks is for tests and 15 marks is for assignments.

Semester 2

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
RCC 2001	Operating System Design	3	3	3	40	60	100	End-of-Semester Exam by University
RCC 2002	Advanced Computer Networks	3	3	3	40	60	100	-do-
*	Elective -1(Stream Elective)	3	3	3	40	60	100	-do-
*	Elective – 2 (Stream Elective)	3	3	3	40	60	100	-do-
*	Elective – 3 (Department Elective)	3	3	3	40	60	100	-do-
RCC 2000	Research Methodology	2	2	3	40	60	100	End-of-Semester Exam by the respective institution
RCC 2101	Seminar	2	2	-	100	-	100	No End-of-sem Exam
RCC 2102	Thesis Preliminary-Part 1	2	2	-	100	-	100	-do-
RCC 2103	Network & OS Laboratory	1	2	-	100	-	100	-do-
	TOTAL	**22**	**23**	**18**	**540**	**360**	**900**	

Note: - Out of 40 marks of Internal Continuous Assessment, 25 marks is for tests and 15 marks is for assignments.

Electives for Semester 2:

Department Electives

RCD 2001	Data Warehousing & Mining
RCD 2002	Software Quality Assurance and Testing
RCD 2003	Simulation & Modeling
RCD 2004	Data Compression
RID 2001	Cyber Laws & Ethics
RID 2002	Advanced Topics in Distributed Systems
RID 2003	Cloud Computing

Stream Elective 1		**Stream Elective 2**	
RCE 2001	Parallel Algorithms	RCE 2006	Computational Geometry
RCE 2002	Information Retrieval	RCE 2007	Advanced Graph Theory
RCE 2003	Network Security	RCE 2008	Soft Computing
RCE 2004	Semantic Web Technology	RCE 2009	Image Processing
RCE 2005	Advanced Complier Design		

* Students can Elective 1, Elective 2 and Elective 3 from the lists of *Departmental Electives*, *Stream Electives 1* and *Stream Electives 2*, respectively.

Semester 3

Code No.	Name of Subject	Credits	Hrs / week	End Sem Exam hours	Marks			Remarks
					Internal Continuous Assessment	End Semester Exam	Total	
*	Elective IV (Stream Elective 3)	3	3	3	40	60	100	End-of-Semester Exam by the respective institution
*	Elective V (Stream Elective 4)	3	3	3	40	60	100	-do-
**	Elective VI (Non Department Elective)	3	3	3	40	60	100	-do-
RCC 3101	Thesis Preliminary-Part 2	5	14		200		200	No End-of-sem Exam
	TOTAL	**14**	**23**	**09**	**320**	**180**	**500**	

Note: - Out of 40 marks of Internal Continuous Assessment, 25 marks is for tests and 15 marks is for assignments.

Electives for Semester 3:

Stream Elective 3

RCE 3001	Complexity Theory
RCE 3002	Distributed Algorithms
RCE 3003	Machine Learning
RCE 3004	Ad-hoc and Sensor Networks

Stream Elective 4

RCE 3005	Modern Computing Paradigms
RCE 3006	Fuzzy Set Theory & Applications
RCE 3007	Decision Support Systems
RCE 3008	Natural Language Processing
RCE 3009	Advanced Computer Graphics

Inter-disciplinary Electives:

RCI 2001	Object Oriented Modeling and Designing
RCI 2002	Software Project Management
RCI 2003	Basic Data Structures and Algorithms
RII 2001	.NET Programming
RII 2002	Java Programming

* Students can Elective 3 and Elective 4 from the lists of *Stream Electives 3* and *Stream Electives 4*, respectively as advised by the course coordinator.

****Non-departmental electives** should be selected from the list of inter-disciplinary electives **offered by other departments**, as advised by the course coordinator.

Semester 4

Code No.	Name of Subject	Credits	Hrs / week	*Evaluation(Marks)*				
				Internal		**External**		**Total**
				Sessional	**Guide**	**Thesis**	**Viva Voce**	
RCC 4101	Thesis Final	12	21	150	150	200	100	600
	TOTAL	**12**	**21**	**150**	**150**	**200**	**100**	**600**

Note: 6 to 8 hours per week is for department assistance

RCC 1001

MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the fundamental concepts in
  - theorem proving
  - Recurrence relations
  - Counting and probability
  - Probability distributions
  - Special graphs and circuits
  - Important structures

Learning Outcomes

- Conceptual understanding of the above topics and ability to apply them in practical situations.

MODULE 1

Techniques for theorem proving: Direct Proof, Proof by Contra position, Proof by exhausting cases and proof by contradiction, Linear-time temporal logic and Branching-time logic-Syntax, Semantics, Practical patterns of specifications, Important equivalences, Adequate sets of connectives. Principle of mathematical induction, principle of complete induction. Recursive definitions, Generating functions, function of sequences calculating coefficient of generating function, solving recurrence relation by substitution and generating functions Solution methods for linear, first-order recurrence relations with constant coefficient, characteristic roots

MODULE 2

Fundamental principles of counting, pigeonhole principle, countable and uncountable sets, principle of inclusion and exclusion – applications, derangements, permutation and combination, Pascal's triangles, binomial theorem, Probability theory – Properties of Probability, Methods of Enumeration, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation, Random variables Discrete Distribution, Binomial Distribution, Mean and variance The Poisson Distribution, Continuous Distribution. Uniform and Exponential Distributions, Normal Distribution

MODULE 3

Graphs, Terminology, Euler tours, planar graphs, Hamiltonian graphs, Euler's formula (proof), four colour problem (without proof) and the chromatic number of a graph, five colour theorem, chromatic polynomials, Warshall's algorithm, Decision Trees, weighted trees

Groups and subgroups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, rings , finite fields, polynomial arithmetic, quadratic residues, reciprocity, discrete logarithms, elliptic curve arithmetic.

References

1. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Application to Computer Science", Tata McGrawHill, 2000
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 7/e, McGraw Hill Inc, 2011
3. Richard Johnson, "Probablity and Statistics for Engineers", 7/e, Prentice-Hall India Private Limited, 2005
4. Robert V. Hogg, Elliot A. Tanis, Meda J. M. Rao, "Probability and Statistical Inference", 7/e,, Pearson Education India, 2006
5. Michael Huth, Mark Ryan "Logic in Computer Science", 2/e, Cambridge University Press, 2004.
6. J. Truss, "Discrete Mathematics for Computer Scientists", 2/e, Addison Wesley, 1999.
7. Bernard Kolman, Robert C Busby,Sharon Kutler Ross, "Discrete Mathematical Structures", 2/e, Prentice-Hall India Private Limited, 1996.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 80% analytical/design problems. There will be three questions (with sub-divisions) from each module out of which two questions are to be answered.

RIC 1001

FOUNDATIONS OF INFORMATION SECURITY

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the founding principles of Information scecurity

Learning Outcomes

- Conceptual understanding of the principles of information security, its significance and the domain specific security issues.

MODULE 1

Security Models as basis for OS security, Introduction to DB Security, Software vulnerabilities Buffer and stack overflow, Phishing. Malware Viruses, Worms
and Trojans. Topological worms. Internet propagation models for worms. Cryptography Topics: Cryptographic hash SHA1, Discrete Log Diffie Helman, Digital certificates. Steganography watermarking.

MODULE 2

*Protocol topics: One way and two w*ay authentication, NeedhamSchroeder protocol, Kerberos basics, Biometrics for authentication. Network security topics: Network layer security – IPSec – overview, IP and IPv6, AH, ESP. Transport layer security SSL. Attacks DoS, DDoS, ARP spoofing - firewalls.

MODULE 3

Law and ethics: Intellectual property rights, computer software copyrights, security policy, ethical hacking, security tools.

References:

1. Bernard Menezes, "Network security and Cryptography", Cengage Learning India, 2010.
2. Behrouz A. Forouzan, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007
3. William Stallings, "Cryptography and Network Security: Principles and Practice", 6/e Pearson Education, 2013.
4. Dieter Gollmann. "Computer Security", John Wiley and Sons Ltd., 2006.
5. Whitman and Mattord, "Principles of Information Security", Cengage Learning, 2006.
6. D. Bainbridge, "Introduction to Computer Law", 5/e, Pearson Education, 2004.
7. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a public World", 2/e, Prentice Hall, 2002.
8. W. Mao, "Modern Cryptography: Theory & Practice", Pearson Education, 2004.
9. H. Delfs and H. Knebl, "Introduction to Cryptography: Principles and Applications", Springer Verlag, 2002.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical problems. There will be three questions (with sub-divisions) from each module out of which two questions are to be answered.

RCC 1002
TOPICS IN DATABASE TECHNOLOGY

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the implementation and management aspects of databases.
- To understand the principles of distributed databases.
- To understand object based data models and their implementation.
- To understand the recent advances in database technology.

Learning Outcomes

- Conceptual understanding of various implementation issues in databases.
- Conceptual understanding of distributed databases.
- Conceptual understanding and ability to work with object based database systems.
- Conceptual understanding of recent technological trends in databases.

MODULE 1

Query Processing Algorithms – Query Optimization Techniques – Transaction Management: Transaction Processing Concepts - Concurrency Control – Deadlocks – Recovery Techniques – Database Security.

Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database – Functions – Distributed RDB design- Transparency– Distributed Transactions - Commit Protocols – Concurrency Control –Deadlocks – Recovery - Distributed Query Processing .

MODULE 2

Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects Object Relational Systems – Case studies : Oracle and Informix.

Web Technology and Databases – Structure of Web pages – HTTP and HTML. Scripting Languages: Javascript, VbScript, PHP – CGI and API – Database Connectivity – JDBC and SQLJ JSP, ASP, JWS and OracleAS – Semi-structured Data and XML Databases: XML Data Model – DTD – XPath and XQuery – Example Queries. Storing XML in databases - RDF (Fundamental Concepts only).

MODULE 3

Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols Active Database Concepts - Triggers – Temporal & Spatial Databases – Multimedia Databases- NoSQL Databases and Big Data.

References

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 5/e, Pearson Education/Addison Wesley, 2011
2. Patrick O'Neil , Elizabeth O'Neil , "Database: Principles, Programming and Performance", 2/e, Morgan Kaufmann, 2011
3. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", 3/e, Pearson Education, 2010.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", 5/e, Tata McGraw Hill, 2006.
5. C.J. Date, A.Kannan and S. Swamynathan,"An Introduction to Database Systems", 8/e, Pearson Education India, 2006.
6. Joe Fawcett, Danny Ayers , Liam R. E. Quin, Beginning XML, 5/e, John Wiley & Sons, 2012
7. Grigoris Antoniou. Frank van Harmelen, "A Semantic Web Primer", The MIT Press, Cambridge, Massachusetts, 2003
8. Jules J. Berman, "Principles of Big Data: Preparing, Sharing and Analyzing Complex Information", Morgan Kufmann, 2013.
9. Pete Warden, "Big Data Glossary", O'Reilly Media Inc, 2011

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) (with sub-divisions) out of which two questions are to be answered.

RCC 1003

ADVANCED DATA STRUCTURES AND ALGORITHMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand about advanced data structures.
- To understand how to analyze and establish correctness of algorithms
- To understand theory behind various classes of algorithms.

Learning Outcomes

- The student should have deep conceptual understanding of advanced data structures and their applications
- He should know the theory behind various classes of algorithms.
- He should be able to design, prove the correctness and analyse new algorithms

MODULE 1

Overview of basic data structures. Amortized Analysis – aggregate , accounting, potential methods. Advanced data structures: binomial heap, fibonacci heap, disjoint sets, Weight-balanced trees, min-max heaps, treaps – analysis of associated algorithms, applications.

Network flow algorithms: properties, Ford-Fulkerson method, maxflow-mincut theorem, Edmonds-Karp heuristics, push-relabel, relabel-to-front algorithms, Dinic's algorithm, MPM algorithm, maximum bipartite matching - analysis of associated algorithms, applications.

MODULE 2

Probabilistic algorithms: basics of probability theory, pseudorandom generators, Numerical algorithms, integration, counting, Monte-Carlo algorithms - verifying matrix multiplication, min-cut in a network. Las Vegas algorithms – eight-queens problem, selection, quicksort, universal hashing, Dixon's factorization

Geometric Algorithms: Plane sweep technique, role of ***sweep- line - status*** and ***event-point-schedule***, line segment intersection problem. Convex Hull : Graham's scan algorithm, Jarvis march algorithm. Finding closest pair of points, proof of correctness.

MODULE 3

Number-Theoretic algorithms: GCD algorithm, modular arithmetic, primality testing, Miller-Rabin test, Integer factorization - Pollard Rho heuristic.

Matrix algorithms: multiplication, decomposition, inversion. String matching: Rabin-Karp, Knuth-Morris-Pratt algorithms.

Overview of Complexity classes – P, NP, Co-NP, NP-hard, NP complete. Space complexity. Complexity classes in randomized algorithms – RP, PP, ZPP, BPP.

References:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to algorithms", Prentice-hall of India Private Limited, New Delhi, 2010.

2. Sartaj Sahni, "Data Structures, Algorithms, and Applications in C++", Mc-GrawHill, 1999.
3. Gilles Brassard and Paul Bratley, "Fundamentals of algorithms", Prentice-hall of India Private Limited, New Delhi, 2001.
4. R.C.T. Lee, S.S. Tesng, R.C. Cbang and Y.T. Tsai "Design and Analysis of Algorithms, A strategic Approach", TMH, 2010
5. Rajeev Motwani, Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 2000.
6. Dexter C. Kozen, "The Design and Analysis of Algorithms", Springer.
7. Jon Kleinberg and Eva Tardos, "Algorithm Design", Pearson Education, 2006.
8. M. H. Alsuwaiyal, "Algorithms Design Techniques and Analysis", World Scientific Publishing Co. Beijing, 1999.
9. S. K. Basu, "Design Methods and Analysis of Algorithms", Prentice Hall India, 2005.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 70% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 1004
ADVANCED SOFTWARE ENGINEERING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To gain a deep understanding of the issues and approaches in modelling, analysing and testing software systems.

Learning Outcomes

- Conceptual understanding of the principles of software modelling and testing.
- Ability to apply the principles in real-cases.

MODULE 1

Introduction: Role of Software Engineer- Quality of software process and product – Systems Approach to Software Engineering – An Engineering Approach to Software Engineering – How has Software Engineering Changed? Modeling the Process and Life Cycle – Software Process Models – Waterfall Model – V Model - Prototyping Model – Spiral Model – Agile methods – Tools and Techniques for Process Modeling – Planning and Managing the Project - Tracking project progress - Project personnel and organization – Effort and schedule estimation - Risk Management – Process Models and Project Management .

MODULE 2

Capturing the Requirement – Eliciting Requirements – Modelling requirements – Reviewing requirements to ensure quality – Documenting requirements – Designing the architecture – Views of Software Architecture – Common Architectural Patterns – Architecture Evaluation and Refinement Criteria for evaluating and comparing design alternatives – Software architecture documentation - Designing Modules – Design Methodology – Design Principles – Object Oriented (OO) design – Representing designs using UML – OO Design Patterns - OO Measurement - Design Documentation Programming Standards and Procedures – Programming Guidelines – Documentation.

MODULE 3

Testing the Programs - Principles of System Testing - Function Testing - Performance Testing – Reliability - Availability and Maintainability - Basics of reliability theory - The Software Reliability Problem - Parametric reliability growth models - Predictive accuracy - The recalibration of software- reliability growth predictions - Acceptance Testing - Installation Testing - Automated System Testing - Test Documentation - Testing Safety Critical Systems -Maintaining the System – Evaluating Products, Processes, and Resources.

References:

1. Shari Lawrence Pfleeger, Joanne M Atlee, “Software Engineering Theory and Practice”, 4/e, Pearson Education, 2011.

2. Software Engineering: A Practitioner's Approach, Roger S Pressman, 7/e,. McGraw Hill Int.Ed., 2010.
3. Ian Somerville, "Software Engineering", 8/e, Addison-Wesley 2007
4. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", 2/e, PHI Learning Private Ltd., 2010
5. Pankaj Jalote, "An Integrated Approach to Software Engineering", 3/e, Springer 2005.
6. K.K Aggarwal & Yogesh Singh, "Software Engineering", New Age International 2007.
7. Norman E Fenton, Shari Lawrence Pfleeger, "Software Metrics: A Rigorous and Practical Approach. 1998

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 1005

ADVANCED COMPUTER ARCHITECTURE

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand issues and techniques in improving performance of processors
- To understand the concepts of pipelining.
- Familiarize with the properties of superscalar processors.
- To understand the multiprocessor systems and cache coherence.

Learning Outcomes

- In-depth knowledge in
  - Measuring performance of processors
  - Instruction level parallelism
  - Vector Architecture
  - Multiprocessor systems and cache coherence.
  - Interconnection networks

MODULE 1

Classes of parallelism and parallel architecture, computer architecture- design issues, Performance measurements, quantitative principles of computer design, Instruction level parallelism -concepts and challenges, Data dependencies and hazards, Basic compiler techniques for exposing ILP.

MODULE 2

Dynamic Scheduling- Tomasulo's approach, Hardware based speculation, ILP using multiple issue and static scheduling, ILP using dynamic scheduling, multiple issue and speculation, case study-Intel Core i7. Data level parallelism-Vector architecture-Vector instruction types, Vector-Access memory schemes , Graphic processing units

MODULE 3

Multiprocessor system interconnects-hierarchical bus system, Cross bar switch and multiport memory, multistage networks, Centralized shared memory architecture, Multiprocessor cache coherence, Schemes for enforcing coherence - Snooping protocol, Limitations, Distributed shared memory and Directory based coherence.

References

1. Hennessy J. L., D. Patterson, "Computer Architecture – A quantitative Approach", 5/e, Morgan Kauffman 2012.
2. Dezso Sima, Terence Fountain, Peter Kacsuk, "Advanced Computer Architectures – A Design Space Approach", Pearson Education India, 2009.
3. Kai Hwang, "Advanced Computer Architecture Parallelism, Scalability, Programmability", Tata McGraw Hill, 2003.
4. John Paul Shen, Mikko Lipasti, "Modern Processor Design – Fundamentals of Superscalar Processors", McGraw Hill International Edition, 2005.

5. The World Wide Web (WWW) Computer Architecture page. http://www.cs.wisc.edu/arch.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 1101
SEMINAR

Lecture	: 0 hrs/ Week	Credits	:	2
Internal Continuous Assessment			:	100 Marks
End Semester Examination			:	0 Marks

Each student is required to select a topic on advanced technologies in Computer Science and allied subject domains and get it approved by the faculty-in-charge of seminar. He/she should give a presentation with good quality slides. An abstract of the seminar should be submitted to the faculty members well in advance before the date of seminar. He/she should also prepare a well documented report on the seminar in approved format and submit to the department. The seminar presentation and report will be evaluated for the award of sessional marks.

RCC 1102
ALGORITHM DESIGN LABORATORY

Practical	: 2hrs/ Week	Credits	:	1
Internal Continuous Assessment			:	100 Marks
End Semester Examination			:	0 Marks

The experiments are based on, but need not be limited to, the topics covered in subject *RCC 1003: Advanced Data structures and Algorithms* and explore the use of the said algorithms and data structures in various application domains.

RCC 2001
OPERATING SYSTEM DESIGN

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the configuration and functions of a typical OS Kernel

Learning Outcomes

- In-depth knowledge in Design and implementation of Kernel modules.

MODULE 1

Overview of basic concepts. Introduction to the Linux Kernel - History of Unix, Introduction to Linux, Overview of Operating Systems and Kernels, Linux Versus Classic Unix Kernels, Linux Kernel Versions. Process Management - Process Descriptor and the Task Structure, Process Creation, The Linux Implementation of Threads, Process Termination. Process Scheduling - Linux's Process Scheduler, Policy, Linux Scheduling Algorithm, Preemption and Context Switching, Real-Time Scheduling Policies.System Calls - Communicating with the Kernel, Syscalls, System Call Handler, System Call Implementation.

MODULE 2

Interrupts and Interrupt Handlers - Registering an Interrupt Handler, Writing an Interrupt Handler, Interrupt Context, Interrupt Control, Bottom Halves – Task Queues, Softirqs, Tasklets, Work Queues. Kernel Synchronization – Introduction, Critical Regions and Race Conditions, Locking, Deadlocks, Contention and Scalability. Kernel Synchronization Methods - Atomic Operations, Spin Locks, Semaphores, Mutexes, Completion Variables, BKL: The Big Kernel Lock, Sequential Locks, Preemption Disabling. Timers and Time Management - Kernel Notion of Time, Jiffies, Hardware Clocks and Timers, Using Timers, Delaying Execution.

MODULE 3

Memory Management - Pages and Zones, Slab Layer, Static Allocation on the Stack, High Memory Mappings, Per-CPU Allocations. The Virtual Filesystem - Filesystem Abstraction Layer, Unix Filesystems, VFS Objects and Data Structures, Superblock Object, Inode Object, Dentry Object, File Object.The Block I/O Layer - Buffers and Buffer Heads, Request Queues, I/O Schedulers. Process Address Space - Address Spaces, Memory Descriptor, Virtual Memory Areas, Page Tables. Devices and Modules - Device Types, Modules, Device Model.

References:

1. Robert Love, "Linux Kernel Development", 3/e, Addison-Wesley, 2010.
2. Daniel Bovet, Marco Cesati, "Understanding the Linux Kernel", 3/e, OReilly Media Inc., 2005.

3. Reilly Christian Benvenuti, "Understanding Linux Network Internals", 1/e, OReilly Media Inc.,2005.
4. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, "Linux Device Drivers", 3/e, OReilly Media Inc., 2005.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical questions. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 2002
ADVANCED COMPUTER NETWORKS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart a deeper understanding of
  - networking design including media, protocols, quality control and congeston management
  - multimedia networking issues and approaches.

Learning Outcomes

- The student becomes aware of the theoretical and practical issues in networking.

MODULE 1

General Principles of Network Design – Network Architecture and Standardization- Network Characteristics-High Speed LANs : Fast Ethernet, Gigabit Ethernet and FDDI– Switched LANs : Basics and Advanced Features- Wireless Transmission : Wireless Media, Wireless Systems, Spread Spectrum Technology, WLANs

MODULE 2

Addressing in TCP/IP Networks : Address Types, IP Address Format (IPV4 and IPV6), Address Assignment, ARP, DNS, DHCP - Internet Protocol - Packet Format, Routing, IPV6
TCP/IP Protocol Stack : TCP and UDP , Routing Protocols, ICMP - Advanced Features of IP Routers : Filtering, IP QoS, NAT, Routers - Wide Area Networks : Virtual Circuit Techniques, X.25, Frame Relay Networks , ATM Technology – IP WANs : Pure IP WANs, IP over ATM, Multiprotocol Label Switching, Network Management

MODULE 3

Congestion and Traffic Management : Congestion Control in Data Networks and Internets, Link Level Flow and Error Control, TCP Traffic Control, Traffic and Congestion Control in ATM Network. Secure Transport Services : IPSec Protected Channel Service, VPN Service, MPLS VPN.
Multimedia Networking : Audio and Video Compression Techniques (Entropy encoding, JPEG Image Compression, MPEG Video Compression), Streaming Stored Audio and Video, Protocol for Realtime Interactive Application, Integrated Services, RSVP, Differentiated Services.

References:

1. Natalia Olifer Victor Olifer," Computer Networks - Principles, Technologies and Protocols for Network Design", - Wiley India(P) ltd. 2006.
2. William Stallings, "High Speed Networks and Internets – Performance and Quality of Service", Pearson India 2005 .
3. James F Kurose and Keith W Ross ," Computer Networking- A Top Down Approach Featuring Internet", 2/e, Pearson Education.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 2000
RESEARCH METHODOLOGY

Lecture	: 2hrs/ Week	Credits	:	2
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objective:

- To formulate a viable research question
- To distinguish probabilistic from deterministic explanations
- To analyze the benefits and drawbacks of different methodologies
- To understand how to prepare and execute a feasible research project

Learning Outcome:

- Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

MODULE 1

Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods *vs.* Methodology. Type of research: Descriptive *vs.* Analytical, Applied *vs.* Fundamental, Quantitative *vs.* Qualitative, and Conceptual *vs.* Empirical.

Research Formulation - Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents.Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

MODULE 2

Research design and methods: Research design - Basic Principles- Need for research design — Features of a good design. Important concepts relating to research design: Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction. Development of Models and research plans: Exploration, Description, Diagnosis, Experimentation and sample designs. Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection - Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-Testing -Generalization and Interpretation.

MODULE 3

Reporting and thesis writing - Structure and components of scientific reports -Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation -Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.

Application of results of research outcome: Environmental impacts –Professional ethics - Ethical issues -ethical committees. Commercialization of the work - Copy right - royalty - Intellectual property

rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

References:

1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi,1990.
2. Panneerselvam, "Research Methodology", Prentice Hall of India, New Delhi, 2012.
3. J.W Bames," Statistical Analysis for Engineers and Scientists", McGraw Hill, New York.
4. Donald Cooper, "Business Research Methods", Tata McGraw Hill, New Delhi.
5. Leedy P D, "Practical Research: Planning and Design", MacMillan Publishing Co.
6. Day R A, "*How to Write and Publish a Scientific Paper*", Cambridge University Press, 1989.
7. Manna, Chakraborti, "Values and Ethics in Business Profession", Prentice Hall of India, New Delhi, 2012.
8. Sople,"Managing Intellectual Property: The Strategic Imperative", Prentice Hall of India, New Delhi, 2012.

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

RCC 2101
SEMINAR

Lecture	: 0 hrs/ Week	Credits	:	2
Internal Continuous Assessment			:	100 Marks
End Semester Examination			:	0 Marks

Each student is required to select a topic on advanced technologies in Computer Science and allied subject domains, preferably one which also relevant as his/her thesis topic, and get it approved by the faculty-in-charge of seminar. He/she should give a presentation with good quality slides. An abstract of the seminar should be submitted to the faculty members well in advance before the date of seminar. He/she should also prepare a well documented report on the seminar in an approved format and submit to the department. The seminar presentation and report will be evaluated for the award of sessional marks.

RCC 2102
THESIS PRELIMINARY – PART 1

Hours/week	: 2	Credits	:	2
Internal Continuous Assessment			:	100 Marks

.The main objective of the thesis is to provide an opportunity to each student to do an independent study and research in the area of specialization under the guidance of a faculty member. The student is required to explore in depth and a topic of his/her own choice, which adds significantly to the body of knowledge existing in the relevant field. The student has to undertake and complete the preliminary work on the stream of specialization during the semester. The thesis work starts in the second semester and has three parts: Preliminary – Part 1 (in Semester 2), Preliminary – Part 2 (in semester 3) and Final (in semester 4).

In Preliminary – Part 1, the student is expected to identify a domain, do enough exploration by reviewing the literature. The student should also identify his problem and objectives. The progress will be assessed by two seminars. The student is also expected to submit an interim report at the end of the semester.

RCC 2103

NETWORK & OPERATING SYSTEM LABORATORY

Practical	: 2hrs/ Week	Credits	:	1
Internal Continuous Assessment			:	100 Marks

The experiments are based on the topics covered in subjects *RCC2001: Operating System Design* & *RCC2002: Advanced Computer Networks* and explore the use of the learned principles in various application domains.

RCC 3101

THESIS PRELIMINARY – PART 2

Hours/week	: 15	Credits	:	5
Internal Continuous Assessment			:	200 Marks

In Preliminary – Part 2, the student is expected further explore his problem, identify solutions, do initial experimentation and result evaluation. The student should also prepare a literature survey report and submit it for review to a suitable conference/journal as advised by the thesis supervisor. The progress will be assessed by the review committee through two seminars and an end-of-semester report.

RCC 4101
THESIS FINAL

Hours/week	: 21	Credits	: 12
Internal Continuous Assessment			: 300 Marks
External Assessment			: 300 Marks

By the first quarter of the semester, the student should compile his/her work by doing the final experimentation and result analysis. Towards the middle of the semester there would be a pre-submission seminar to assess the quality and quantum of work by the department evaluation committee. This would be the pre-qualifying exercise for the students for getting approval for the submission of final thesis. The decision of the departmental committee in this regard is final and binding. The committee can make recommendations to improve the quality or quantity of the work done. The student is expected to publish technical papers related to his/her research in peer reviewed journals/conferences. The final evaluation of the thesis would be done by an external examiner. The external examiner's comments regarding the quality and quantity of work is an important decisive factor in the final acceptance/rejection of the thesis.

Electives

Departmental Elective

RCD 2001
DATA WAREHOUSING & MINING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the fundamental and advanced concepts Data Warehousing and Data Mining

Learning Outcomes

- Conceptual understanding of
  - Data cleaning, analysis and visualization
  - Data mining techniques.
  - Web mining and Spatial mining

MODULE 1

Data warehousing – Multidimensional data model, OLAP operation, Warehouse schema, Data Warehousing architecture, warehouse server, Metadata, OLAP engine, Data warehouse Backend Process , Data Warehousing to Data Mining. Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective, Knowledge Discovery in Database Vs Data mining. Data Preprocessing**:** Preprocessing, Cleaning, Integration, Transformation, Reduction, Discretization, Concept Hierarchy Generation, Introduction to DMQL.

MODULE 2

Similarity measures, Bayes Theorem, Classification -regression, Bayesian classification, Decision tree based algorithm-ID3, Neural network based algorithm- supervised learning, back propagation, gradient-descent algorithm, Rule based algorithm-IR, PRISM, Clustering algorithm – Hierarchical algorithm –Dendrograms- Single link algorithm, Partitional algorithm-Minimum spanning tree, squared error, K-means, PAM algorithm.

MODULE 3

Association Rules : Apriori algorithm, Sampling algorithm, Partitioning algorithm, Parallel and distributed algorithms, Web mining-web content mining, web structure mining, web usage mining, Spatial mining- spatial queries, spatial data structures, Generalization and specialization, spatial classification, spatial clustering, Introduction to temporal mining.

References:

1. Margaret H Dunham, "Data Mining – Introductory and Advanced Topics", Pearson India, 2005.
2. Ian H. Witten, Eibe Frank, Mark A. Hall," Data Mining: Practical Machine Learning Tools and Techniques", 3/e, Morgan Kaufmann, 2011.

3. J. Han, M. Kamber, "Data Mining: Concepts and Techniques", 2/e, Morgan Kaufman, 2006.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/query/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Departmental Elective

RCD 2002
SOFTWARE QUALITY ASSURANCE AND TESTING

Lecture	:	3 hrs/ Week	Credits	: 3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- Understand the theoretical aspects of software testing
- Demonstrate the knowledge of the existing testing methods
- Demonstrate the knowledge of static and dynamic analysis methods
- Demonstrate the knowledge of applying testing and analysis methods in software development and maintenance

Learning Outcomes

- Students get in-depth skill to quantitatively assess the quality of software; they also understand the fundamental principles and tools for software-testing and quality assurance.

MODULE 1

Software Quality Assurance Framework and Standards SQA Framework: Software Quality Assurance, Components of Software Quality Assurance Software Quality Assurance Plan: Steps to develop and implement a Software Quality Assurance Plan â€“ Quality Standards: ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcom Balridge, 3 Sigma, 6 Sigma

Software Quality Metrics: Product Quality metrics, In-process Quality Metrics, Metrics for Software Maintenance, Examples of Metric Programs Software Quality metrics methodology: establishing quality requirements, Identifying Software quality metrics, Implement the software quality metrics, analyze software metrics results, validate the software quality metrics â€“ Software quality indicators, Fundamentals in Measurement theory.

MODULE 2

Software Testing Strategy and Environment Establishing testing policy, structured approach to testing, test factors, Economics of System Development Life Cycle (SDLC) Testing Software Testing Methodology Defects hard to find, verification and validation, functional and structural testing, workbench concept, eight considerations in developing testing methodologies, testing tactics checklist, Software Testing Techniques Black Box, Boundary value, Bottom up, Branch coverage, Cause Effect graphing, CRUD,

Database, Exception, Gray Box, Histograms, Inspections, JADs, Pareto Analysis, Prototyping, Random Testing, Risk based Testing, Regression Testing, Structured Walkthroughs, Thread Testing, Performance Testing, White Box Testing

MODULE 3

Software Testing Tools Taxonomy of Testing tools, Methodology to evaluate automated testing tools, Load Runner, Win runner and Rational Testing Tools, Java Testing Tools, JMetra, JUNIT and Cactus.

Testing Process Eleven Step Testing Process: Assess Project Management Development Estimate and Status, Develop Test Plan, Requirements Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results, Acceptance Test, Report test results, testing software installation, Test software changes, Evaluate Test Effectiveness.
Testing Specialized Systems and Applications Testing Client/Server Web applications, Testing off the Shelf Components, Testing Security, Testing a Data Warehouse

References:

1. William E. Perry, "Effective Methods for Software Testing", 2/e, Wiley
2. Mordechai Ben Menachem, Garry S. Marliss, "Software Quality", Thomson Learning

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Departmental Elective

RCD 2003
SIMULATION & MODELING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the methodology for modeling and simulation of continuous, discrete time as well as discrete-event systems.
- To have basic knowledge on simulation software and use it in solving of engineering problems, analysis and validation of the results

Learning Outcomes

- The student attains theoretical and practical skills in modelling and simulation of various genre of systems.
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MODULE 1

Types of evaluation strategies (experimentation, simulation, and modelling). Modelling: Types of modelling (physical and analytical). Analytical Modelling (queueing theory): Single server and multiple server model. Case studies from Operating systems, Computer Networks, Computer Organization. Operational Laws, Asymptotic Analysis, Bounds on System throughput and response time. Balanced bound analysis, Mean-value analysis (MVA), Approximate-MVA, Convolution Algorithm. Limitations of analytical modelling (queueing theory). Simulation: Types of simulation. Advantages and limitations. Discrete event simulation: Simulation of single server, two servers connected in series, and servers in parallel.

MODULE 2

Modelling arrival time/service time/inter-arrival time of jobs using probability distributions (random variables). Introduction to random variables: random number generation, uniform random number generation, random variables, expectation, variance. Generation of non-uniform random variables: Bernoulli, Binomial, Poisson, Geometric, Exponential, Negative binomial, and Pascal. CS applications of each random variables. Poisson process, homogeneous/non-homogeneous poisson processes. Random variate generation. Inverse transformation method, rejection method.

MODULE 3

Analysis of simulation results. Introduction to MATLAB/Sci-LAB. Methods for curve fitting. Numerical method techniques for root finding, solving linear equations.

Computer Modelling and Simulation Practice: Introduction to simulation languages: Simscript and simulators like NS2, Opnet. Simulation of Single server/multiple servers. Using Simscript/C/C++, Simulation of Deterministic automaton, Push down automaton, and Turing Machines. Simulation

of Stop and wait and sliding window protocols. Simulation of CSMA/CD LAN. Simulation of Wireless LAN.

References:

1. Ross, Simulation, Academic Press, 2002. Chapters 1-6.
2. Raj Jain, The art of computer systems performance analysis, John Wiley and Sons 1991. Chapters 1,2,3, 30-35, 24-29.
3. Edward D.Lazowska et.al. Quantitative System Performance (Computer System Analysis Using Queueing Network Models); chapters 1-6.
4. Lecture notes of Professor Raj Jain, Washington University in Saint Louis.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Departmental Elective

RCD 2004
DATA COMPRESSION

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- Develop theoretical foundations of data compression, concepts and algorithms for lossy and lossless data compression, signal modelling and its extension to compression with applications to speech, image and video processing.

Learning Outcomes

- Awareness about various data compression techniques and their practical significance.

MODULE 1

Compression techniques,Compression ratio, lossless & lossy compression, Huffman coding, Non binary Huffman Algorithms, Adaptive Coding, applications,Arithmetic Coding,applications, Finite Context Modeling.

Dictionary based Compression, Sliding Window Compression, LZ77,LZ78, LZW compression. Predictive Coding - prediction and partial match, move to front coding, Run Length encoding.

MODULE 2

Speech Compression & Synthesis: Digital Audio concepts, Sampling Variables, Lossless compression of sound, lossy compression & silence compression. Image Compression, Transform based techniques, Wavelet Methods, adaptive techniques. Images standards, JPEG Compression, Zig Zag Coding .

MODULE 3

Video Compression- motion compensation, MPEG standards,recent development in Multimedia Video compression,packet video, Fractal techniques. Comparison of compression algorithms, Implementation of compression algorithms.

References:

1. David Solomon, Data compression: the complete reference, 2/e, Springer-verlag, New York. 2000.
2. Stephen Welstead, Fractal and wavelet Image Compression techniques , PHI, 1999.
3. Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 2003.
4. Sleinreitz ―Multimedia System‖ Addison Wesley.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Departmental Elective

RID 2001
CYBER LAWS & ETHICS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart sufficient knowledge on the fundamental principles of IPR, various types of cyber crimes and Indian and international cyber laws.

Learning Outcomes

- The student gains insight into ethical issues, cyber crimes and cyber laws.

MODULE 1

Intellectual property rights, computer software copyrights, copyright in databases and electronic publishing, law of confidence, patent laws, trademarks, product designs, international law .
Computer contracts, liability for defective hardware and software, software contracts, web and hardware contracts, electronic contracts and torts, liabilities.

MODULE 2

Computer crime, computer fraud, hacking, unauthorized modification of information, piracy, computer pornography and harassment.

MODULE 3

Cyber laws in India, IT Act 2000, Offences under IT act. Protection pf IPR in Cyber space in India. International cyber laws and crimes, COE convention of cyber crimes. data subjects' rights, ethical issues in computer security, case studies.

References

1. D. Bainbridge, *Introduction to Computer Law*, 5/e, Pearson Education, 2004.
2. Harish Chander, *Cyber Laws and IT Protection*, PHI Learning Private Limited, 2012.
3. P. Duggal, *Cyber law: the Indian Perspective*, Saakshar Law Publications, Delhi, 2005.
4. C. P. Fleeger and S. L. Fleeger, *Security in Computing*, 3/e, Pearson Education, 2003.

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

Departmental Elective

RID 2002
ADVANCED TOPICS IN DISTRIBUTED SYSTEMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart deeper understanding in
  - Architecture and issues of distributed systems
  - Distributed algorithms
  - *Hadoop* system

Learning Outcomes

- The student gains insight into conceptual and practical aspects of distributed systems.

MODULE 1

Definition of Distributed System, Goals, Types of Distributed Systems, System Architecture : Centralized, Decentralized & Hybrid Architecture. Processes: Threads, Virtualization, Clients, Servers, Code migration. Communication: Message Oriented, Stream Oriented and Multicast Communication.

Naming**:** Names, Identifiers and Addresses, Flat Naming, Structured Naming and Attribute Based Naming. Consistency and Replication: Reasons for Replication, Data Centric and Client Centric Consistency Models, Replica Management, Consistency Protocols. Distributed Object Based Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, Security.

MODULE 2

Distributed Algorithms: Models of Distributed Computation, Preliminaries, Causality, Distributed Snapshots, Modeling a Distributed Computation, Failures in a Distributed System. Algorithms in General Synchronous Networks: Leader Election, Breadth First Search, Minimum Spanning Tree, Shortest Path, Maximal Independent Set.

MODULE 3

Hadoop: Introduction, Comparison with Other Systems. Analyzing Data with Hadoop- Map and Reduce, Scaling Out: Data Flow, Combiner Functions, Running a Distributed Map Reduce Job. Map Reduce Types and Formats, Features. Hadoop Distributed File System: Concepts and Basic Operations. Administering Hadoop.

References:

1. Andrew S. Tanenbaum, Maarten Van Steen.” Distributed Systems – Principles and Paradigms “, 2/e, PHI, 2004.

2. Randy Chow Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis", Pearson Education, 2009.
3. Nancy A. Lynch, Morgan," Distributed Algorithms", Kaufmann Publishers, Inc, 1996.
4. Tom White, "Hadoop: The Definitive Guide", 1/e, O'reilly, 2012.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Departmental Elective

RID 2003
CLOUD COMPUTING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- Understanding cloud computing, and compare with existing technologies.
- Understand how to develop a cloud service

Learning Outcomes

- Design and develop cloud services for everyone.
- Use Cloud Service and collaborate it with various application and taking it online.

MODULE 1

Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Advantages of Cloud Computing – Disadvantages of Cloud Computing – Companies in the Cloud Today – Cloud Services Web-Based Application – Pros and Cons of Cloud Service Development – Types of Cloud Service Development – Software as a Service – Platform as a Service – Web Services – On-Demand Computing – Discovering Cloud Services Development Services and Tools – Amazon Ec2 – Google App Engine – IBM Clouds.

MODULE 2

Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists – Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation.

MODULE 3

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files. 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.

References

1. Dan C. Marinescu , Cloud computing: Theory and Practice, Morgan Kaufmann, 2013
2. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing,: From Parallel Processing to the Internet of Things, 1/e, Morgan Kaufmann , 2011
3. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, 2008.

4. Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for Ondemand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, 2008.

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 1

RCE 2001
PARALLEL ALGORITHMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- Understand the principles and applications of parallel algorithms

Learning Outcomes

- Students gain in-depth theoretical and practical knowledge on parallel algorithms.

MODULE 1

Parallel computer. Need of parallel computers, models of computation, Analyzing algorithms, expressing algorithms. Broadcast, All sums and selection algorithms on SIMD. Searching a sorted sequence – EREW, CREW SMSIMD algorithms. Searching a random sequence – SMSIMD, tree and Mesh interconnection super computers. Sorting – Sorting on a linear array, sorting on a mesh, sorting on EREW SIMD computer, MIMD enumeration sort, MIMD quick sort, sorting on other networks.

MODULE 2

Matrix Transposition, Mesh transpose, shuffle transpose, EREW transpose. Matrix operations – matrix-by-matrix multiplications, mesh multiplications, cube multiplication, Matrix by vector multiplication. Linear array multiplication, tree multiplications. Solving numerical problems, solving systems of linear equations SIMD algorithms and MIMD algorithms.

MODULE 3

Numerical problems – finding roots of nonlinear equations – SIMD and MIMD algorithms, solving partial differential equations, computing eigen values. Graph theoretical problems – solving graph theoretical problems, computing connectivity matrix, finding connected components, all pairs shortest path, traversing combinatorial spaces, sequential tree traversals, Minimal Alpha-Beta tree , MIMD Alpha-Beta algorithms, parallel cutoff storage requirements, recent trends and developments.

References:

1. S.G.Akl, "Design and Analysis of parallel algorithms", PrenticeHall, Inc. 1989.
2. S.G.Akl, "Parallel Sorting algorithm", Academic Press, 1985
3. M.J.Quin, "Parallel computing – theory and Practice", McGrawHill, New York, 1994.
4. S. Lakshmivarahan and S.K.Dhall, "Analysis and design of Parallel Algorithms – Arithmetic & Matrix problems", McGrawHill, New York, 1990.
5. V. Kumar, A. Grama, A. Gupta, and G. Karypis, "Introduction to Parallel Computing", San Francisco: Benjamin Cummings / Addison Wesley, 2002.
6. B. Wilkinson, M. Allen, "Parallel Programming", 2/e, Pearson Education Inc, 2007.

7. M .J. Quin, "Parallel Programming in C with MPI and openMP", Tata McGraw Hill, 2007.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 1

RCE 2002
INFORMATION RETRIEVAL

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the principles and techniques of information retrieval

Learning Outcomes

- Students gain in-depth theoretical and practical knowledge of information retrieval techniques and ability to apply them in practical scenarios.

MODULE 1

Introduction: Goals and history of IR. The impact of the web on IR. The role of artificial intelligence (AI) in IR. Basic IR Models: Boolean and vector-space retrieval models; ranked retrieval; text-similarity metrics; TF-IDF (term frequency/inverse document frequency) weighting; cosine similarity. Basic Tokenizing Indexing, and Implementation of Vector-Space Retrieval: Simple tokenizing, stop-word removal, and stemming; inverted indices; efficient processing with sparse vectors; python implementation.

MODULE 2

Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure; Evaluations on benchmark text collections. Query Operations and Languages: Relevance feedback; Query expansion; Query languages. Text Representation: Word statistics; Zipf's law; Porter stemmer; morphology; index term selection; using thesauri. Metadata and markup languages (SGML, HTML, XML). Web Search, Search engines; spidering; metacrawlers; directed spidering; link analysis (e.g. hubs and authorities, Google PageRank); shopping agents.

MODULE 3

Text Categorization and Clustering: Categorization algorithms: naive Bayes; decision trees; and nearest neighbor. Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM). Applications to information filtering; organization; and relevance feedback. Recommender Systems: Collaborative filtering and content-based recommendation of documents and products. Information Extraction and Integration: Extracting data from text; XML; semantic web; collecting and integrating specialized information on the web.

References:

1. Manning, Raghavan, and Schutze, *Introduction to Information Retrieval*, Cambridge University Press, 2008.
2. R. Baeza-Yates, B. Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", Pearson Education India, 1/e, 2009.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 1

RCE 2003
NETWORK SECURITY

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart understanding of various hardware and software aspects of security in networks.

Learning Outcomes

- The student gains knowledge in problems and approaches related to secure network management.

MODULE 1

Introduction: Security trends, security attacks, security mechanisms, Network Security model, Review of intrusion detection systems.Review of cryptographic algorithms and protocols: cryptanalysis, Message authentication, secure hash functions, Digital signatures. Standards: Kerberos v4 – configuration, authentication, encryption, message formats. Kerberos v5 – cryptographic algorithms, message formats. PKI – trust models, revocation. Real-time communication security, IPSec overview, AH, ESP, IKE – phases.

MODULE 2

Email security, Security services for Email, establishing keys, privacy, authentication, message integrity. PEM & S/MIME – structure of messages, encryption, source authentication and integrity protection, message formats. PGP encoding, anomalies, object formats. Web security: Web security considerations, SSL/TLS – attacks, exportability, encoding. Secure electronic transaction.

MODULE 3

Network management security: SNMP, Basic concepts of SNMPv1, SNMPv3. Wireless security: Wireless LAN Specifications, Wireless network security stack, WEP. Firewalls: Firewall design principles, trusted systems, packet filters, application level gateways, encrypted tunnels.

References:

1. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private communication in a public World", 2/e, PHI, 2002.
2. W. Stallings, "Cryptography and Network Security Principles and practice", 3/e, Pearson Education Asia, 2003.
3. William Stallings, "Network Security Essentials", 2e, Prentice Hall, 2003.
4. Schiller J., "Mobile Communications", Pearson Education Asia,2/e, 2009.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", TMH, 2008.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 1

RCE 2004
SEMANTIC WEB TECHNOLOGY

Lecture	:	3 hrs/ Week	Credits	: 3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the principles, practices and applications of Semantic Web Technology.

Learning Outcomes

- Conceptual and practical understanding of
  - Semantic Web
  - Ontology and its applications
  - Ontology tools

MODULE 1

Introduction to Semantic Web – layered approach - web documents in XML – schema - name space – querying - processing. RDF - Schema – Web Resource Description using RDF- RDF Properties – Topic Maps and RDF – axiomatic semantics of RDF and RDF schema – inference system RQL and querying. Logic and inference – monotonic rules – syntax and semantics – non-monotonic rules – examples – rule mark-up in XML. Querying with SPARQL.

MODULE 2

Ontologies – Syntax Structure – Semantics – Pragmatics - Components – Types - Ontological Categories – Philosophical Background -Sample - Knowledge Representation Ontologies – Top Level Ontologies – Linguistic Ontologies – Domain Ontologies. Traditional Ontology Languages – LOOM- OKBC – OCML – Flogic. Ontology Markup Languages – SHOE – OIL - DAML + OIL. Web Ontology Language OWL – syntax semantics – examples.

MODULE 3

Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning – Importing and Processing Ontologies and Documents – Ontology Learning Algorithms – Evaluation Ontology management tools – need for management – development process – target ontology – ontology mapping – skills management system – ontological class – constraints – issues. – Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based annotation Tools. Web Services – Semantic Web Services - Case Study for specific domain – Security issues – current trends.

References:

1. Grigoris Antoniou, Frank van Harmelen, "A Semantic Web Primer (Cooperative Information Systems)", The MIT Press, 2009
2. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez "Ontological Engineering: with examples from the areas of Knowledge Management, e- Commerce and

the Semantic Web", Springer, 2004
3. Alexander Maedche, "Ontology Learning for the Semantic Web", Springer, 2002
4. John Davies, Dieter Fensel, Frank Van Harmelen, "Towards the Semantic Web: Ontology – Driven Knowledge Management", John Wiley & Sons Ltd., 2003.
5. John Davies, Rudi Studer, Paul Warren, "Semantic Web Technologies: Trends and Research in Ontology-based ystems",Wiley Publications, 2006.
6. Dean Allemang, James Hendler, "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL", Morgan Kaufmann, 2008
7. Steffen Staab, Rudi Studer, "Handbook on Ontologies (International Handbooks on Information Systems)", 1/e, Springer, 2004

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems/queries. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 1

RCE 2005
ADVANCED COMPILER DESIGN

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand various compiler optimization techniques.
- To understand back end design of compilers.

Learning Outcomes

- Conceptual understanding of theory behind compiler design.
- Ability to build a complete compiler.

MODULE 1

Introduction to Advanced Topics Review of compiler phases, Informal Compiler Algorithm Notation, Symbol Table Structure – local and global symbol tables, Intermediate Representations – HIR, MIR and LIR. Run Time Issues.

Control Flow Analysis – basic blocks, DFS, dominators and postdominators, loops, dominator tree, dominance frontier.

MODULE 2

Data Flow Analysis – reaching definitions, available expressions, live variable information. Dependency analysis, Alias analysis.

Review of Optimizations – constant folding, constant and copy propagation, dead code elimination. Redundancy Elimination – common subexpression elimination, loop invariant code motion, partial redundancy elimination. Value numbering. Loop Optimizations – induction variable elimination. Procedure Optimization, Static Single Assignment(SSA) form.

MODULE 3

Machine Dependent tasks: Register Allocation - graph coloring, coalescing. Local and Global Instruction Scheduling, Advanced Topics in Code Scheduling, Low Level Optimizations, Introduction to inter-procedural analysis and scheduling, Machine code generation.

References:

1. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kauffmann, 1997.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, Pearson Education, 2009.
3. Keith D. Cooper, Linda Torczon, “Engineering a Compiler”, 2/e, Morgan Kauffmann, 2011.
4. Andrew W. Appel, “Modern Compiler Implementation in Java”, Cambridge University Press, 2009.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 2

RCE 2006
COMPUTATIONAL GEOMETRY

Lecture	:	3 hrs/ Week	Credits	: 3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To fill the gap between geometric properties and algorithm design
- To familiarize data structures used for developing efficient algorithms
- To learn efficient techniques for solving geometric problems

Learning Outcomes

- Capable to develop efficient algorithms by exploiting geometric properties
- Capable in identifying properties of objects, expressing them as lemmas
- and theorems and proving their correctness.
- Capable in applying learned algorithm in diversified fields like data base
- Searching, data mining, graphics, image processing pattern recognition,
- computer vision motion planning and robotics

MODULE 1

Geometric Preliminaries, Data Structures for geometric problems : **DCEL** (Doubly Connected Edge List), **Quad trees**, **Kd-trees** and **BSP** (Binary Space Partition) trees. Geometric Searching - Planar Straight Line Graph (PSLG), Point Location Problem, Location of a point in a planar subdivision, Plane Sweep Technique-applications- line segment inter section using plane sweep ,Slab method, Regularization of PSLG, Monotone polygons , Range Searching using Kd-trees.

MODULE 2

Convex Hulls, Convex Hull Algorithms in the Plane -- Graham's Scan Algorithm, **Jarvi's March**, Divide and Conquer Algorithm, Quick Hull Algorithm. Triangulation— Polygon Triangulation, ***Art Gallery Theorem***, ***Fisk's*** proof of Art Gallery theorem. ***Post Office Problem*** - Voronoi Diagrams- Properties , computing Voronoi diagram, Applications in the plane , Delaunay Triangulation

MODULE 3

Introduction to Visibility Problems-- Definition of direct visibility, Point visibility and Edge visibility, Algorithm for computing point-visible region inside a polygon, Kernel of a simple polygon , Linear time algorithm for computing Kernel. Visibility graph, Shortest path for a ***point Robot***

References:

1. Franco P. Preparata, Michael Ian Shamos, "Computational Geometry- An Introduction", Texts and Monographs in Computer Science , Springer – Verlag
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars " Computational Geometry, Algorithms & Applications" Springer

3. Herbert Edelsbrunner, "Algorithms in Combinatorial Geometry", EATCS Monographs on Theoretical Computer Science, Springer – Verlag.
4. Art Gallery Theorems, Joseph O' Rourke, Oxford Press.
5. Joseph O' Rourke, " Computational Geometry in C", Cambridge University Press

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical /design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 2

RCE 2007
ADVANCED GRAPH THEORY

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart deeper understanding in advanced concepts in graph theory and their practical applications.

Learning Outcomes

- Students become aware of the advanced concepts of graph theory and gain ability to apply those concepts in practical scenarios.

MODULE 1

Graphs, Connectivity and Hamiltonicity: Graphs: Graphs as models- Paths and connectedness-Cutnodes and Blocks- Graph classes and graph operations. Connectivity: Connectivity and edge connectivity - Menger's theorem - Properties of n-connected graphs- Circulants, Hamiltonicity: Necessary or sufficient conditions- Connectivity and Hamiltonicity- Graph operations and Hamiltonicity - Generations of Hamiltonicity. Centers: The Center and Edge connectivity- Self Central Graphs - The Median – Central Paths- Other Generalized Centers

MODULE 2

Extremal Distance Problems: Radius- Small Diameter- Diameter- Long paths and Long Cycles. Distance sequences: The Eccentric Sequence - Distance Sequences - Distribution - Path Sequence - Other Sequences. Matrices: The Adjacency Matrix - The incidence Matrix - The Distance Matrix. Convexity: Closure Invariants-Metrics on Graphs - Geodetic Graphs- Distance Heredity Graphs. Symmetry: Groups- Symmetric Graphs - Distance Symmetry

MODULE 3

Digraphs: Digraphs and connectedness - Acyclic Digraphs - Matrices and Eulerian Digraphs- Long paths in Digraphs- Tournaments. Graph Algorithms: Polynomial Algorithms and NP completeness - Path Algorithms and Spanning Trees - Centers - Maximum Matchings - Two NP-Complete Problems. Networks: The Max- Flow Min-Cut Theorem - Minimum Spanning Trees - Traveling Salesman Problem - Shortest Paths - Centers - Critical Path Method.

References:

1. Fred Buckley and Frank Harary , “Distance in Graphs”, Addison – Wesley, 1990.
2. C. R. Flouds: “Graph Theory Applications”, Narosa Publishing House, 1994.
3. Harary F: “Graph Theory”, Addison- Weslwy pub. 1972.
4. Deo N: “Graph Theory with Applications to Engineering and Computer Science”, Prentice Hall Inc. 1974.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% problems/proofs. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 2

RCE 2008
SOFT COMPUTING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To familiarize the salient approaches in soft computing, based on artificial neural networks, fuzzy logic, and genetic algorithms.
- To introduce applications of soft computing to different research areas in Computer Science / Information Technology.

Learning Outcomes

- Understand advantages and disadvantages of soft computing.
- Students will be able to apply soft computing techniques to research problems

MODULE 1

Artificial Neural Network Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model, Properties of neural network, Typical architectures: single layer , multilayer, competitive layer; Different learning methods: Supervised, Unsupervised & reinforced; Com mon activation functions; Feed forward, Feedback & recurrent N.N; Application of N.N; Neuron.

MODULE 1

Models Of Neural Network:Architecture, Algorithm & Application of – McCullo h-Pitts, Hebb Net, Perceptron (with limitations & Perceptron learning rule Convergence theorem), Back propagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet , Kohonen Self Organizing Maps, ART1,ART2.

Fuzzy Sets & Logic : Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic—Laws of propositional logic, Inference; Predicate logic—Interpretations, Inference; Fuzzy logic—Quantifiers, Inference; Fuzzy Rule based system; Defuzzification methods; FAM

MODULE 3

Genetic Algorithm Basic concept; role of GA in optimization, Fitness function, Selection of initial population, Cross over(different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation; Genetic Programming; Schema theorem; Multi-objective & Multimodal optimization in GA; Applications: Travelling Salesman Problem, Graph Coloring problem.

Hybrid Systems : GA based BPNN(Weight determination, Application); Neuro Fuzzy Systems—Fuzzy BPNN--fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled G.A.

References:

1. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", 2/e, John Wiley India, 2012
2. Simon Haykin, "Neural Networks- A Comprehensive Foundation", 2/e, Pearson Education.
3. T.S. Rajasekaran, G.A. Vijaylakshmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms – Synthesis and Applications", Prentice-Hall India
4. Sanchez, Takanori, Zadeh, "Genetic Algorithm and Fuzzy Logic System", World Scientific
5. Goldberg David, "Genetic Algorithms", Pearson Education
6. Zimmermann H. J , "Fuzzy Set Theory & Its Applications", Allied Publishers Ltd.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 2

RCE 2009
IMAGE PROCESSING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart understanding of the issues and methodologies in digital image processing

Learning Outcomes

- Student gets deeper understanding of principles and techniques and algorithms for digital image processing

MODULE 1

Introduction digital image representation: fundamental steps in image processing, elements of digital image processing systems, digital image fundamentals, simple image model, sampling and quantization, relationship between pixels – image geometry

MODULE 2

Image transforms : Introduction to Fourier transform – discrete Fourier transform, properties of 2d-fourier transform (DFT), other separable image transforms, Hotelling transform, Image enhancement, point processing, spatial filtering , filtering in frequency domain Image restoration: degradation model, diagonalization of circulant and block circulant matrices, inverse filtering, least mean square filter.

MODULE 3

Image compression: image compression, elements of information theory, error-free Compression, lossy compression,image compression standards. Image reconstruction from projections: basics of projection, parallel beam and fan beam projection, method of generating projections, Fourier slice theorem, filtered back projection algorithms. Point detection, line detection and edge detection in images, Image segmentation.

References:

1. Rafael C., Gonzalez & Woods R.E., "Digital Image Processing", Pearson Education.
2. Rosenfeld A. & Kak A.C., "Digital Picture Processing", Academic Press
3. Jain A.K, "Fundamentals of Digital Image Processing", Prentice Hall, Eaglewood Cliffs, NJ
4. Schalkoff R. J., "Digital Image Processing and Computer Vision", John Wiley
5. Pratt W.K., "Digital Image Processing", John Wiley

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 3

RCE 3001
COMPLEXITY THEORY

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand fundamental complexity classes, randomized computation and parallel computation.

Learning Outcomes

- Thorough understanding of various complexity classes and computation strategies.

MODULE 1

Review of time and space related complexity classes, hierarchy theorem, reachability method. Space complexity – PSPACE, PSPACE completeness, class L and NL, Co-NL, NL completeness, alternation. NP complete problems – problems in NP, variants of satisfiability, graph theoretic problems, sets and numbers.

MODULE 2

NP and Co-NP, primality, function problems. Randomized computation – algorithms, complexity classes – RP, ZPP, PP, BPP, branching program, random sources. Cryptography – one-way functions, trapdoor functions, cryptography and complexity, randomized cryptography, interactive proofs, zero-knowledge.

MODULE 3

Approximation and complexity, non-approximability. Parallel computation – algorithms, class NC, P-completeness, RNC algorithms. Polynomial hierarchy – class DP, P^{NP}, FP^{NP}. Computation that counts – class #P, #P-complete, ®P, exponential time.

References:

1. Christos H. Papadimitriou, "Computational Complexity", Addison-Wesley Publishing Company Inc.
2. Michael Sipser, "Introduction to the Theory of Computation", Thompson Course Technology, 2/e, 2006.
3. Rajeev Motwani, Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 2000.
4. Vazirani V., "Approximation Algorithms", Springer, 1/e, 2004.
5. Mitzenmacher M and Upfal E., Probability and Computing, Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, 2005.
6. Jorg Rothe, "Complexity Theory and Cryptology: An Introduction to Crypto-complexity", Springer-Verlag, 2005.

Structure of the Question paper

For the End Semester Examination the question paper will consist of 50% analytical problems and 50 % Theory. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 3

RCE 3002
DISTRIBUTED ALGORITHMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- Provide an introduction to the most important basic results in the area of distributed
- Algorithms.
- Should be able to use basic distributed algorithms and impossibility results
- Ability to apply distributed algorithms in large computer networks to multiprocessor
- shared-memory systems.

Learning Outcomes

- Understand various synchronous algorithms and consensus problems
- Understand various asynchronous shared memory algorithms and asynchronous network algorithms with the help of I/O automata.
- Understand partially synchronous algorithms

MODULE 1

Synchronous Network Algorithm: Synchronous Network Model, Leader election in a synchronous ring, Algorithms in General Synchronous Networks- Flooding algorithm – Breadth First Search – Shortest Paths- Minimum Spanning Tree – Maximal Independent Algorithm- Distributed consensus with link failures.

MODULE 2

Asynchronous Algorithms: Asynchronous System model - I/O automata- Operations on automata – Fairness – Inputs and outputs for problems – Properties and proof methods.
Asynchronous Shared Memory Algorithms: Asynchronous Shared Memory Model, Mutual Exclusion – Dijkstra's Mutual Exclusion algorithm – Lock out free Mutual Exclusion algorithms, Mutual Exclusion using Read – Modify - Write Variables - TicketME algorithm, Resource allocation, Consensus.

MODULE 3

Asynchronous Network Algorithms: Asynchronous Network Model, Basic asynchronous network algorithms, synchronizers -The Local synchronizer – The safe synchronizer – Implementations - Applications.
Partially synchronous algorithms – MMT Timed automata – General Timed automata – Basic Definitions and operations – Transforming MMT automata into General Timed Automata.

References

1. Distributed Systems. S. Mullender (ed.). Addison-Wesley, 1993
2. Distributed Algorithms. N. Lynch. Morgan Kaufmann, 1996
3. Introduction to Distributed Algorithms. G. Tel. Cambridge Univ. Press, 2000.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two question are to be answered by the students.

Stream Elective 3

RCE 3003
MACHINE LEARNING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart a deeper understanding of machine language techniques, tools and applications.

Learning Outcomes

- Students gains understanding of conceptual and practical aspects of machine learning and ability to apply the techniques in real-world scenarios.

MODULE 1

Introduction to learning. Types of Learning, Rote learning, Learning by parameter adjustment, Learning by general problem solving, Concept learning, Learning by analogy. Introduction to machine learning, Why machine learning. Types of problems in machine learning, History of machine learning, Aspects of inputs to training, Learning systems, Machine learning as a classifier, Intelligent agents, Machine learning applications. Evaluation of machine learning algorithms. Neural Networks. Artificial Neural Nets, ANN Basics, ANN - Learning Process , Types of Networks, Perceptron, Multilayer Perceptron, Error back Propagation Algorithm, RBF Networks.

MODULE 2

Association Learning, Basics of Association , Apriori Algorithm , Eclat Algorithm , FP Growth Algorithm, Tertius Algorithm. Statistical Learning, Stochastic Processes, Markov Process, Hidden Markov Models, Three Basic Problems for HMMs, Forward - Backward Procedure , Viterbi Algorithm, Baum-Welch Algorithm, Linear Classifiers , Quadratic Classifiers, Decision Trees, C 4.5 Algorithm, ID3 Algorithm, Random Forest, Bayesian Networks, Bayesian Networks Learning, Limitation of Bayesian Networks, Expectation Maximization (EM), EM Algorithm, Self Organising Maps, Learning Process of SOM, Adaptive Resonance Theory, Important ART Networks, ART Architecture, ART Algorithms

MODULE 3

Supervised Learning, Support Vector Machines, Inductive Logic Programming, Generic ILP Algorithm, Principal Approaches to ILP, Characteristics of ILP System, Case Base Reasoning, How CBR Works?, Case Representation, CBR Issues, Ensemble Classifiers, AdaBoost algorithm, Bayes Optimal Classifier , Nearest Neighbourhood techniques, Fuzzy Network, Fuzzy Systems, Info Fuzzy Networks, Fuzzy Neural Systems. Unsupervised learning. Clustering, K-Means Clustering , Fuzzy Clustering, Hierarchical Clustering , Agglomerative and Divisive Clustering, Hierarchical Agglomerative Clustering, Cluster Similarity, Reinforcement Learning, Markov Decision Problem, Q-learning, Q-Learning

Algorithms, Temporal Difference Learning, On-Policy and Off-Policy Learning, Advantages of TD Prediction Methods, Learning Automata.

References:

1. Anderson J.A., "An Introduction to Neural Networks", Prentice Hall India, 1999.
2. Hertz J. Krogh, R.G. Palmer, "Introduction to the Theory of Neural Computation", AddisonWesley,, 1991.
3. Stephen Marsland Machine Learning: An Algorithmic Perspective, CRC Press, 2009
4. Vojislav Kecman, "Learning and Soft Computing", 1/e, Peason Education, 2004.
5. Stuart Russell and Peter Norvig "Artificial Intelligence: A Modern Approach, 3/e, Peason Education., 2011.
6. Shakhnarovish, Darrell, and Indyk,, "Nearest-Neighbor Methods in Learning and Vision". *MIT Press*, 2005.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical/design problems and 60 % Theory. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 3

RCE 3004
ADHOC AND SENSOR NETWORKS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- The primary objective of this course is to introduce to the area of wireless sensor networks and learn the concepts and principles behind WSN.
- To learn WSN network design, sensor node embedded system design and implementation.
- On WSN network management, the focus is mainly on wireless network security which is a very important issue in WSN.

Learning Outcomes

- After passing the course, a student comprehends the Wireless Sensor Networks (WSN) as a new technology area in research and industry.
- A student is familiar with the main standards and specifications of WSNs and identifies the key building blocks for them.
- A student can define and explain the essential challenges of resource constrained WSN design and implementation, including applications, interfaces, energy-efficient protocols and platform functionalities.
- A student can apply both theoretical and practical tools for WSN design and utilization and design potential application scenarios for WSNs.

MODULE 1

Introduction : Fundamentals of wireless communication technology, the electro magnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques,multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wirelesss networks, issues in design of sensor network, sensor network archeitecture, data dissemination and gathering.

MODULE 2

MAC Protocols : Issues in desiging MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

Routing Protocols : Issues in designing a routing protocol, classification of routing protocols,table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

MODULE 3

QoS and Energy Management : Issues and Challenges in providing QoS, classifications,MAC, network layer solutions, QoS frameworks, need for energy

management,classification, battery, transmission power, and system power management schemes.

References:

1. C. Siva Ram Murthy, B. S. Manoj, "AdHoc Wireless Networks ", Pearson Education, 2008.
2. Feng Zhao, Leonides Guibas, "Wireless Sensor Networks ", Elsevier, 2004.
3. Jochen Schiller, "Mobile Communications ", 2/e, Pearson Education, 2003.
4. William Stallings, "Wireless Communications and Networks ", Pearson Education, 2004.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 4

RCE 3005
MODERN COMPUTING PARADIGMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- The ability to work with various computing revolutions like HPC, Cluster, Grid and Cloud computing
- Ability to use virtualization techniques to implement computing approaches like cloud computing

Learning Outcomes

- Understand various computing paradigms, its issues and its applications in the business
- Understand various tools and methods to implement Grid and Cloud computing

MODULE 1

High performance computing - cluster, grid, meta-computing, middleware. Programming models: shared memory, message passing, peer-to-peer, broker-based. Introduction to PVM and MPI. Cluster Computing – Cluster Computing at a Glance – Cluster Setup and its Administration – Cluster Architectures – Detecting and Masking Faults – Recovering from Faults . Grid Computing – Fundamentals – Benefits of Grid Computing – Grid Terms and Concepts – Grid Security – Grid Architecture Models – Grid Topologies.

MODULE 2

Cloud Computing – Cloud Architecture – Cloud Storage – Cloud Services. Types of Cloud Service Development. Software as a Service – Platform as a Service – Infrastructure as a Service, Identity as a Service – Data Storage in the Cloud – Collaboration in the Cloud – Securing the Cloud – Service Oriented Architecture. Familiarization of EUCALYPTUS – an open source software framework for cloud computing. Familiarization of CloudSim: A Toolkit for Modeling and Simulation Cloud Computing Environments

MODULE 3

Virtualization - Virtualization Types – Desktop Virtualization – Network Virtualization – Server and Machine Virtualization – Storage Virtualization – Virtual Machine Basics – Hypervisor - Server Consolidation. Virtual machines products-Xen Virtual machine monitors- Xen API – VMware – VMware product-Vmware Features – Microsoft Virtual Server – Features of Microsoft Virtual Server Software framework for distributed computing - MapReduce - Hadoop.

References

1. Rajkumar Buyya, "High Performance Cluster Computing – Architecture and Systems", Pearson Education.
2. K. Hwang, G. C Fox, J. J. Dongarra, "Distributed and Cloud Computing -From

Parallel Processing to the Internet of things", Elsevier, 2012.
3. Bart Jacob, Michael Brown, et al, Introduction to Grid Computing, IBM Red Books
4. Kris Jamsa, "Cloud Computing", Jones and Bartlett Learning, LLC
5. Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Que Publishing.
6. William von Hagen, "Professional Xen Virtualization", Wrox Publications, 2008.
7. Kai Hwang, Geoffrey Fox et al, "Distributed and Cloud Computing", Elsevier, 2010
8. Dinkar Sitaram, Geetha manjunath, "Moving to the Cloud", Elsevier, 2010

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 4

RCE 3006
FUZZY SET THEORY AND APPLICATIONS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand Fuzzy Set Theory and the basis of fuzyy logic and fuzzy logic applications such as fuzzy control and fuzzy decision making

Learning Outcomes

- The students who succeeded in this course should be
    - able to examine the Set Theory problems.
    - able to interpret the systems which include fuzzines within the scope of fuzzy set theory .
    - able to combine the information of decision theory and the information of fuzzy set theory.
    - able to improve the proof techniques of Fuzzy Set Theory.
    - able to solve problems that include uncertainty with using Fuzzy Set Theory.

MODULE 1

Introduction – crisp sets an overview – the notion of fuzzy sets – Basic concepts of fuzzy sets – classical logic an overview – Fuzzy logic. Operations on fuzzy sets - fuzzy complement – fuzzy union – fuzzy intersection – combinations of operations – general aggregation operations Crisp and fuzzy relations – binary relations – binary relations on a single set– equivalence and similarity relations.

MODULE 2

Compatibility or tolerance relations– orderings – Membership functions – methods of generation – defuzzification methods.General discussion – belief and plausibility measures – probability measures– possibility and necessity measures – relationship among classes of fuzzy measures.

MODULE 3

Classical logic: An overview – fuzzy logic – fuzzy rule based systems – fuzzy decision making – fuzzy logic in database and information systems – fuzzy pattern recognition – fuzzy contriol systems.

References

1. George J Klir and Tina A Folger, “Fuzzy Sets, Uncertainty and Information”, Prentice Hall of India, 1998.
2. H.J. Zimmerman, “Fuzzy Set Theory and its Applications”, 4/e, Kluwer Academic Publishers, 2001.
3. George Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, Prentice Hall of India, 1997.

4. Timothy J Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill International Editions, 1997.
5. Hung Nguyen and Elbert Walker, "A First Course in Fuzzy Logic, 2/e,, Chapman and Hall/CRC, 1999.
6. Jerry M Mendel, "Uncertain Rule-based Fuzzy Logic Systems: Introduction and New Directions, PH PTR, 2000.
7. John Yen and Reza Lengari, "Fuzzy Logic: Intelligence, Control and Information", Pearson Education, 1999.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 60% analytical/design problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 4

RCE 3007
DECISION SUPPORT SYSTEMS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To understand the theory and applications of various types of DSS

Learning Outcomes

- The student should have conceptual strength in DSS and should be able apply it identify the most apt DSS in a practical scenario.

MODULE 1

Introduction to – Concepts of Data, Information, Information Systems & End Users. Systems Concepts: Open System, Closed System; Information Systems and Systems Concept. Building Information System: System Analysis and Design – Systems Development Cycle (Identification of Requirements, Feasibility Study, System Analysis, Design And Implementation), Prototyping Evolution of Information Systems: PS,OAS,MIS,DSS,EIS,ES
Decision Making: Introduction and Definitions, Simons Decision Making Model, How Decisions are Supported, DSS Configurations, DSS Characteristics and Capabilities. Components of DSS, DSS Classifications DSS Modeling-Static and Dynamic Models, Certainty, Uncertainty, and Risk, Sensitivity Analysis, What-IF, and Goal Seeking,

MODULE 2

Making Decisions in Groups: Group Decision Support System(GDSS),Characteristics, Process, Benefits, and Dysfunctions, Supporting Group work with Computerized Systems, Tools for Indirect and Indirect Support of Decision Making, From GDSS to GSSKnowledge Management System: Definition and types of Knowledge, Frame work for Knowledge Management Knowledge Representation Techniques: Rules, Frames, Semantic Networks, Introduction to Business Intelligence: Origins and Drivers of Business Intelligence, General Process of Intelligence Creation and Use, Characteristics of Business Intelligence, Towards Competitive Intelligence, Successful BI Implementation, Structure and Components of BI, Future trends.

MODULE 3

Data Warehousing Definitions and Concepts, Types of Data warehouse. Business Analytics - Online Analytical Processing (OLAP), Reporting and Queries, Multidimensionality Knowledge Discovery in Databases (KDD), framework of KDD. Data Mining Concepts and Applications, Framework of datamining, Text Mining, Web Mining Usage, Benefits, and Success of Business Analytics.

References:

1. Turban, Efrain, "Decision Support & Business Intelligent Systems", 8/e, Pearson Education
2. Marakas, George.M, "Decision Support Systems in the 21st Century", Pearson Education
3. Mallach, Efrem G., " Decision Support & Data Warehouse Systems", Tata McGraw-Hill
4. Keen,Peter G.W, "Decision Support System and Organizational Perspective", Addison-Wesley
5. Theierauff, Robert J., "Decision Support System for Effective Planning", Prentice Hall, 1982.
6. Krober,Donald W., and Hugh J. Watson, "Computer Based Information System", New York,1984.
7. Andrew P. Sage, "Decision Support System Engineering", John Wiley & Sons, New York,1991.
8. Leod. Raymond Me JR, "Management Information Systems", 5/e, Macmillian Publishing Company, 1993.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% design/analytical problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 4

RCE 3008
NATURAL LANGUAGE PROCESSING

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives

- To impart conceptual and application level aspects of NLP.

Learning Outcomes

- The student gets a thorough understanding of the theory and applications.

MODULE 1

Natural Language Processing, Ambiguity and uncertainty in language. The Turing test, Chomsky hierarchy, regular languages, and their limitations. Finite state automata. Practical regular expressions for finding and counting language phenomena. N-gram Language Models and Information Theory: n-gram models. Entropy, relative entropy, cross entropy, mutual information, perplexity. Statistical estimation and smoothing for language models.

MODULE 2

Statistical Machine Translation (MT), Statistical Alignment Models and Expectation Maximization (EM) and its use in statistical MT alignment models ; complete statistical MT system decoding and A* Search. Information Extraction (IE) and Named Entity Recognition (NER). Information sources, rule-based methods, evaluation (recall, precision). Introduction to supervised machine learning methods. Naïve Bayes (NB) classifiers for entity classification, Maximum Entropy Classifiers

MODULE 3

Syntax and Parsing for Context-Free Grammars (CFGs): Parsing, treebanks, attachment ambiguities. Context-free grammars. Top down and bottom-up parsing, empty constituents, left recursion, and repeated work, Probabilistic CFGs. Lexicalized Probabilistic Context Free Grammars (LPCFGs): Lexicalization and lexicalized parsing, Modern Statistical Parsers, Search methods in parsing: Agenda-based chart, A*, and "best-first" parsing. Dependency parsing. Discriminative parsing.

References:

1. Daniel Jurafsky and James H. Martin. “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”. 2/e, Prentice Hall, 2008.
2. Christopher D. Manning, Hinrich Schuetze, “Foundations of Statistical Natural Language Processing, MIT Press, 2003.

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 40% analytical problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.

Stream Elective 4

RCE 3009
ADVANCED COMPUTER GRAPHICS

Lecture	: 3 hrs/ Week	Credits	:	3
Internal Continuous Assessment			:	40 Marks
End Semester Examination			:	60 Marks

Course Objectives:

- To introduce geometric modeling and modeling transformations
- To learn different techniques for representing Solids
- To learn visible surface determination algorithms
- To learn concepts of global illumination modeling using advanced Ray tracing algorithms and Radiosity methods

Learning Outcomes:

- Be able to apply appropriate mathematical models to solve computer graphics problems

MODULE 1

Geometric modelling :Hierarchy in Geometric models, relationship between model, application program and Graphical System, Defining and Displaying structures, Modelling Transformations, Hierarchical structure networks, Appearance attribute handling in hierarchy, Screen updating and rendering modes, Interaction, Output features, Implementation issues, Optimizing display of hierarchical models, Limitations of SPHIGS.
User Interface Software: Basic interaction handling models, Window management systems, Output handling in window systems, Input handling in window systems, User Interface Management systems.

MODULE 2

Solid Modelling: Regularized Boolean set of operations, Sweep representations, Boundary representations, Winged –Edged representations, Boolean Set Operations, Spatial Partitioning representations, Octrees, Constructive Solid Geometry, Comparisons of representations. Visible surface determination algorithms: Scan line algorithm, Area subdivision algorithm, visible surface ray tracing. Illumination and shading: Illumination models, diffuse reflection and Specular reflection, illumination models, Shading models for polygons. Global illumination algorithms. Recursive ray tracing and distributed ray tracing. Radiosity methods, Combining radiosity and ray tracing.

MODULE 3

Image manipulation and storage : Geometric transformation of images, Filtering, Multipass transforms, Generation of transformed image with filtering, Image Compositing, Mechanism for image storage. Advanced geometric and raster transforms: Clipping-clipping polygon against rectangles and other polygons. Animation: Conventional and computer assisted animation, Methods of controlling animation. Advanced Raster graphics architecture. Display processor system, Standard graphics pipeline, Multiprocessor Graphics System.

References:

1. James D. Foley, Andries van Dam, Steven K. Feiner and F. Hughes John, "Computer Graphics, principles and Practice in C", 2/e, Pearson Education.
2. Donald Hearn and M. Pauline Baker, " Computer Graphics", Prentice Hall India
3. Alan Watt , " 3D Computer Graphics", Addison Wesley

Structure of the Question paper

For the End Semester Examination the question paper will consist of at least 50% analytical problems. There will be three questions from each module (with sub-divisions) out of which two questions are to be answered by the students.