

Revised Application Documentation: Version 4 /22 August, 2016

QUALIFICATION FILE – C level

Name and address of submitting body:

National Institute of Electronics and Information Technology (NIELIT)

(An ISO 9001:2008 Certified Organisation)

Electronics Niketan, 6 CGO Complex, Lodhi Road, new Delhi-110003.

Ministry of Electronics and Information Technology (MeitY)

Telephones- 011-24363330-1-2, 24366577-79-80

Name: Rajneesh Kumar Asthana.

Position in the organisation Deputy Director (Systems)

Address if different from above NA

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List of documents submitted in support of the Qualifications File

1. Detailed Curriculum (Annexure -I)
2. Industry Validation (Annexure -II)
 - a) Recognition by AICTE vide no: Academic/AIB-ITE(X)/2008-09 dated 19.07.2010 “C” level Programme equivalent to M.E/M.Tech in Computer Science.
 - b) Recognition by Government of Odisha, industry department vide no. VTTI-26/2004. Dated 29.10.2005, “C” Level as equivalent to M.Tech Course
3. Multiple entry exit channel (Annexure -III)
4. Evolution of Course (Annexure -IV)
5. International Recognition (Annexure -V):
 - a) Agreement between India and Japan NIELIT C Level Course equivalent to **Application System Engineer Standards** of Japan Information Technology Engineers Examination Center (JITEC) of Information Technology Promotion Agency (IPA), **Japan**
 - b) Agreement between India and Singapore NIELIT C Level Course with one year experience equivalent to Associate Certified IT Project Manager (CITPM) of **National Infocomm Competency Centre (NICC) Singapore** and Singapore Computer Society (SCS)
6. Constitution of Governing Council/Academic Advisory Committee(Annexure -VI)

7. Previous Question Paper- <http://nielit.gov.in/content/old-question-papers-0> (Annexure -VII)
8. Year-wise students registered(Annexure -VIII)

QUALIFICATION FILE SUMMARY

Qualification Title	C level Course		
Qualification Code	NIELIT/IT/3/94		
Body/bodies which will assess candidates	Examination Cell, National Institute of Electronics and Information Technology 6-CGO Complex, Electronics Niketan Lodhi Road, New Delhi. 110003.		
Body/bodies which will award the certificate for the qualification.	National Institute of Electronics and Information Technology 6-CGO Complex, Electronics Niketan Lodhi Road, New Delhi. 110003.		
Body which will accredit providers to offer the qualification.	National Institute of Electronics and Information Technology 6-CGO Complex, Electronics Niketan Lodhi Road, New Delhi. 110003.		
Occupation(s) to which the qualification gives access	Project Manager, IT Consultant, Training faculty, R & D Scientist, System Specialist		
Proposed level of the qualification in the NSQF.	8		
Notional Learning Hours	2700 hours (2 Years)		
Entry requirements / recommendations.	Level 'B' / B.Tech / BE / MCA / M.Sc / Master's Degree in Mathematics / Statistics / Operation Research / MBA (or equivalent) with B.Sc / BA (Mathematics / Statistics)/GATE (Computer) followed in each case, by one and half year relevant experience.		
Progression from the qualification.	<u>In Academic</u> <ul style="list-style-type: none"> ➤ The student may also be allowed to pursue research in any University/IIT/NIT <u>Professional</u> <ul style="list-style-type: none"> ➤ Initially candidate can work as Project Manager whose role would be organising the various professional people working on a project to carry out risk assessment and make sure that all the aims of the project are met. ➤ After completion of this course, students eligible to become a faculty in Computer Science & Engineering/IT Department of Engineering college & universities. 		
Planned arrangements for RPL.	<ul style="list-style-type: none"> • It will be incorporated once RPL strategy is finalized 		
Formal structure of the qualification			
Title of unit or other component (include any identification code used)	Mandatory/ Optional	Estimated size (learning	Level
Bridge Course			

C0-R4.B1: To familiarize with Mathematical Sciences	Mandatory	120	8
C0-R4.B2: Develop Knowledge in Operating System	Mandatory	120	
C0-R4.B3: Get familiarize with Java through Data Structure	Mandatory	120	
C0-R4.B4: Understand the architecture of Computer System	Mandatory	120	
Semester I			
C1-R4: Get the Knowledge of Advanced Computer Graphics	Mandatory	120	
C2-R4: Develop Knowledge of Advanced networks	Mandatory	120	
C3-R4: Learn Computing using Mathematical Methods	Mandatory	120	
C4-R4: learn and explain the advance version of Algorithms	Mandatory	120	
C5-R4: Get the Concepts of Data Warehousing and Data mining	Mandatory	120	
Lab I: Graphics and Visualization	Mandatory		
Lab II: Data Network and Management	Mandatory		
Semester II			
C6-R4: Develop the Concepts of Multimedia Systems	Mandatory	120	
C7-R4: Acquire knowledge of Digital image processing & Computer vision	Mandatory	120	
C8-R4: Understand different aspects of Information Security	Mandatory	120	
C9-R4: Understand various aspects of Soft Computing	Mandatory	120	
C10-R4: Acquire Knowledge in Software Systems	Mandatory	120	
Lab III: Image Processing and Computer Vision+Multimedia Systems	Mandatory		
Lab IV: Information Security+Soft Computing	Mandatory		
Semester III (Any two from the following to be chosen)			
CE1.1-R4: To get familiarize with Properties & Application of Digital Signal Processing	Optional	120	
CE1.2-R4: Develop Knowledge of Machine Learning		120	
CE1.3-R4: To get familiarize with Tools, Technique & Modes of Cyber Forensic & Law		120	
CE1.4-R4: Get Concepts of Planning, Estimation Scheduling Risk Analysis & Resource allocation of Project Management		120	
CE1.5-R4: Understand various layers, Operating system		120	

& Security Concepts of Mobile Computing			
C11-R4: Dissertation-I	Mandatory	330	
Semester IV			
C12-R4: Dissertation-II	Mandatory	450	

SECTION 1 **ASSESSMENT**

Name of assessment body:

Examination Cell,

National Institute of Electronics and Information Technology
6-CGO Complex, Electronics Niketan
Lodhi Road, New Delhi. 110003.

Will the assessment body be responsible for RPL assessment?

Give details of how RPL assessment for the qualification will be carried out and quality assured.

Presently only candidates undergoing training shall be assessed. Later on candidates having experience and knowledge shall be assessed. The information will be provided on finalization of such procedure.

Describe the overall assessment strategy and specific arrangements which have been put in place to ensure that assessment is always valid, consistent and fair and show that these are in line with the requirements of the NSQF:

The emphasis is on practical demonstration of skills & knowledge based on the performance criteria. Each OUTCOME is assessed & marked separately. Student is required to pass in all OUTCOMES individually and marks are allotted. Following assessment methodologies are used.

- A. Written Assessment (Multiple Choice Questions) and viva voice
- B. 4 Practical Assessment
- C. 2 Projects

The assessment results are backed by following evidences.

- 1 The assessor collects a copy of the attendance for the training done under the scheme. The attendance sheets are signed and stamped by the In charge / Head of the Training Centre.
- 2 The assessor verifies the authenticity of the candidate by checking the photo ID card issued by the institute as well as any one Photo ID card issued by the Central/Government. The same is mentioned in the attendance sheet.
- 3 The assessor assigns roll number.
- 4 The assessor takes photograph of all the students along with the assessor standing in the middle and with the centre name/banner at the back as evidence.

Please attach any documents giving further information about assessment and/or RPL.

ASSESSMENT EVIDENCE

Job Role

- Project Manager
- IT Consultant
- Training faculty
- R & D Scientist
- System Specialist

Title of Unit/Component:

(Detailed Curriculum attached As Annexure-I)

Assessable Outcomes	Assessment criteria for the outcome	Total Mark	Written(Part-I)	Written(Part-II)
C0-R4.B1: To familiarize with Mathematical Sciences	Learn Linear Algebra(Matrices, Vectors, Determinants)	100	60	40
	Learn Calculus, Differential & Integral Calculus			
	Learn and apply Analytical Geometry			
	Learn Infinite Series & Sequence			
	Learn Probability Theory and Distributions			
	Learn Statistics			
	Total			
C0-R4.B2: Develop Knowledge in Operating System	Learn and execute operating system and its architecture	100	60	40
	Follow Process management			
	Learn and follow Storage Management			
	Identify I/O Systems and File System			
	Identify various Distributed Systems			
	Execute Security Problem and case studies			
	Perform the case study to understand operating System			
Total	100	60	40	
C0-R4.B3 Get familiarize with Java through Data Structure	Learn Algorithm and Data Structure.	100	60	40
	Learn and apply object oriented programming and java			
	Identify various performance analysis Techniques			
	Learn stack, Queue and linked list			
	Identify various recursion method			
	Follow Tree, Graphs and Strings Concepts			
	Execute sorting and searching Method			
Total	100	60	40	

C0-R4.B4: Learn the architecture of Computer System	Learn Computer Arithmetic	100	60	40
	Follow Register Transfer language			
	Identify pipelined and no pipelined computers			
	Learn basic computer programming			
	Manage fundamentals of I/O			
	Manage memory Organization of computer			
	Architecture of SISD, SIMD and MIMD			
	Total	100	60	40
C1-R4: Get the Knowledge of Advanced Computer Graphics	Learn 2D geometry, Clipping and 3D geometry	100	60	40
	Representation of curves and surfaces of a polygon			
	Knowledge in solid Modeling			
	Concepts of Visual Surface determination			
	Methods of Illumination models and surface- rendering			
	Identify various color models			
	Learn and apply basics of Animation			
	Total	100	60	40
C2-R4: Develop Knowledge of Advanced networks	Basics of networking Concepts	100	60	40
	Various performance model			
	Follow multiple Access Networks			
	Learn ATM features, Services and traffic control			
	Apply IP version 6 features			
	Follow Multicast and Internetworking			
	Get the knowledge of TCP and UDP			
	Concepts of Multimedia and networking			
	Total	100	60	40
C3-R4: Learn Computing using Mathematical Methods	Basics of Probability and Information	100	60	40
	Learn Stochastic Process			
	Queuing Theory and performance Evaluation			
	Various optimization method			
	Laplace and Fourier Transfer techniques			
	Total	100	60	40
C4-R4: Learn the advance version of Algorithms	Follow methods of analyzing various types of algorithms	100	60	40
	Efficiency of algorithms as a function of its input size in terms of both time and memory			
	Follow properties of algorithms			
	Effective and efficient exploration of advanced data structures to be used in algorithms			

	Total	100	60	40
C5-R4: Get the Concepts Data Warehousing and Data mining	Follow background of data mining and warehousing	100	60	40
	Data pre-processing process			
	Data warehousing and OLAP technology			
	Data cube Computation and Generalization			
	Basic Concepts of Mining frequent patterns, Associations and Correlations			
	Classification and predictions			
	Cluster Analysis			
	Mining Stream, Time Series and Sequence Data			
	Application of Data warehousing and Mining			
	Total	100	60	40
Practical - I	Graphics & Visualization	100	80 (P)	20 (Viva)
Practical – II	Data Network & Management	100	80 (P)	20 (Viva)
C6-R4: Develop the Concepts of Multimedia Systems	Develop concepts of fundamental principles of speech , image and video capture, compression and decompression	100	60	40
	Follow methods involved in the design of multimedia systems and their applications			
	Learn about various features of virtual reality systems			
	Demonstrate the future directions of multimedia systems development			
	Total	100	60	40
C7-R4: Develop knowledge of Digital image processing & Computer vision	Follow fundamentals image processing & Computer Vision	100	60	40
	Various image formation			
	Apply Image enhancement and restoration technique			
	Various Color image processing technique			
	Wavelets and Multi resolution Processing			
	Image Compression			
	Edge and boundary Detection			
	Morphological Image processing			
	Motion estimation, detection and Tracking			
	Total	100	60	40
C8-R4: Explain different aspects of Information Security	Basics of modular arithmetic	100	60	40
	State and prove Fermat's little Theorem & its			
	Generalization using Euler's function & use			
	Implement the RSA cipher			

	Follow proofs of some theorems in the Number Theory			
	Implement and break simple substitution ciphers and the Vigenere cipher			
	Provide historical background to cryptography			
	Learn strength and weaknesses of different encryption algorithms			
	Various attacks on encryption schemes			
	Concepts of Hash Functions			
	Public-key Cryptography Concepts			
	Integrity and Digital Signature			
	Total	100	60	40
C9-R4: Demonstrate various aspects of Soft Computing	Fundamentals of soft computing	100	60	40
	Concepts of genetic algorithm & modelling			
	Fundamentals of Optimization and regression			
	Neural network concept			
	Fuzzy logic			
	Hybridization of neural network and fuzzy logic			
	Total	100	60	40
C10-R4: Acquire Knowledge in Software Systems	Basics of Software Engineering and different life cycle models	100	60	40
	Specification and Requirements in engineering			
	Design concepts and method			
	Analysis and Design of Object oriented methodology			
	Modeling with UML			
	Testing Object oriented system and Quality Assurance			
	Concepts of Software architecture and Agent			
	Total	100	60	40
Practical - III	Image Processing & Computer Vision + Multimedia	100	80 (P)	20 (Viva)
Practical - IV	Information Security+Soft Computing	100	80 (P)	20 (Viva)
Elective: (Two Module out of the following five modules to be chosen)				
CE1.1-R4: To get familiarize	Analysis of various types of signal	100	60	40

with Properties & Application of Digital Signal Processing	Concepts Mathematics for signal			
	Follow the properties of signal			
	Identify various transform in digital signal processing			
	filter design technique			
	Use DSP Co-processor and Advance DSP concepts			
	Total	100	60	40
CE1.2-R4: Develop Knowledge of Machine Learning	Learning of the General-to- Specific Ordering	100	60	40
	Apply and execute Decision Tree Learning			
	Apply Artificial Neural Networks technique			
	Bayesian Learning			
	Concepts of Computational Learning Theory			
	Evaluation of learning algorithm			
	Total	100	60	40
CE1.3-R4: To get familiarize with Tools, Technique, Modes of Cyber Forensic & Law	Learn the basics and principles of Cyber Forensics and Law	100	60	40
	Able to do step-by-step through the basics of investigation			
	Introduce the tools and procedures required to legally seize and forensically evaluate a suspect machine			
	Follow rules of evidence, chain of custody, standard operating procedures			
	Manipulation of technology to conceal illegal activities and how cyber forensics can uncover them			
	Total	100	60	40
	CE1.4-R4: Get Concepts of Planning, Estimation Scheduling Risk	Basis of Software Project Management System	100	60
Learn Overview of Project Planning				
Follow Concepts of Project Estimation				

Analysis & Resource allocation of Project Management	Apply Concepts of Project Scheduling			
	Follow Organization and Team Structure			
	Apply Risk Analysis and Management technique			
	Follow Resource Allocation			
	Project Tracking and Configuration Management			
	Execute Project Contract Management			
	Apply Software Quality Assurance			
	Total	100	60	40
CE1.5-R4: Learn various layers, Operating system & Security Concepts of Mobile Computing	Learn Basic of mobile computing	100	60	40
	Learn and implement GSM and CDMA Architecture			
	Follow various local area mobile communication Access			
	Apply routing algorithm for mobile network			
	How mobile used in transport layer			
	basic concept of mobile database			
	Learn and apply mobile operating system			
	Execute security in mobile computing			
C11-R4: Dissertation-I	After completion of 1 st 2 Semester	100	80	20 (Viva)
C12-R4: Dissertation-II	After Completion of 3 rd Semester	300	240	60 (Viva)
	Grand Total	2400	1520	880

Means of assessment 1

No of Practical Examination : Four

Duration of each Examination : Three hour duration including viva-voce

Max. marks in each Examination : 100=80 (Practical) + 20 (Viva)

Grading : Students will be awarded grades in practical examinations based on the marks scored by them in the practical and viva voce. Every candidate has to pass in both Theory and Practical examinations

Dissertation - I

Every candidate should do a Dissertation individually and no grouping is allowed. „C“ Level student can submit the Dissertation-I only after clearing 10 papers from the first two semesters and appearing both elective papers in semester III.

Dissertation - II

At this academic level, the Dissertation is of great significance in the testing of a candidate's virtuosity in Information Technology and judges his or her ability to independently take charge of Dissertation/System development.

All „C“ Level candidates are required to get the synopsis of the Dissertation and the brief bio-data of the supervisor/Guide approved from the Society. The synopsis should clearly mention the scope of the Dissertation. The Dissertation is to be taken up only after obtaining the approval of the Society.

Pass percentage

To qualify for a pass in a module, a candidate must have obtained at least 50% in each theory and practical examination. The marks will be translated into grades, While communicating results to the candidates. The gradation structure is as below:-

Pass percentage Grade

Failed (<50) F

50%-54% D

55%-64% C

65%-74% B

75%-84% A

85% and over S.

SECTION 2

EVIDENCE OF NEED

What evidence is there that the qualification is needed?

Recognition has been given by the Government of India to NIELIT „C“ level examination conducted by the NIELIT as equivalent to M.Tech Course in IT for the purpose of employment to the posts and services under Central Government.

What is the estimated uptake of this qualification and what is the basis of this estimate?

NIELIT is having 35 centres and 900 accredited centres spread all over India and minimum capacity of each centre is 20 so approx. 75000 candidates per year can appear in this course. The duration of the course is 2 Year (4 semesters of 6 months each).

What steps were taken to ensure that the qualification(s) does/do not duplicate already existing or planned qualifications in the NSQF?

As the understanding and adoption models of QPs evolve in the industry and across its sub-sectors, we foresee consolidation of qualification packs as a natural progression. The Qualification does not exist as per information available in public domain.

What arrangements are in place to monitor and review the qualification(s)? What data will be used and at what point will the qualification(s) be revised or updated?

The Qualification is to be monitored and reviewed every two years.
The following data will be used

1. Results of assessments
2. Employer feedback will be sought post-placement
3. Student feedbacks
4. Workshops and seminar for reviewing the qualifications
5. Industry Requirements
6. Consultation/ Tie-up with Industries or Expert for review of the Curriculum.

SECTION 3

SUMMARY EVIDENCE OF LEVEL

Level of qualification: 8

Summary of Direct Evidence:

Justify the NSQF level allocated to the QP by building upon the five descriptors of NSQF.

Explain the reasons for allocating the level to the QP.

Generic NOS is/are linked to the overall authority attached to the job role.

Title : C Level			Level : 8
NSQF Domain	Outcomes of the Qualification/Component	How the job role relates to the NSQF Level Descriptors	NSQF Level
Process required	It requires a command of specialised theoretical and practical skill. They can involve in variable routine and non-routine context with them.	Comprehensive, cognitive, theoretical knowledge and practical skills to develop creative solutions to abstract problems.	8
Professional knowledge	After acquiring professional knowledge on C level Course, they can gain theoretical knowledge and practical skills to develop creative solutions to abstract the problem. They perform variety of task so that they can develop into a number of different industry & Sections. Development of specific technical expertise, possibly leading to contributing at national & international technical conference	Undertakes self-study; demonstrates intellectual independence, analytical rigour and good communication	8
Professional skill	They gain wide range of cognitive and practical skills to generate solutions to specific problems in a field of work and study. They identified the problem and get unique solution. They have good communication skill. They can provide information & Guidance to assist members to develop their expertise & recognise & plan their learning needs.		8
Core skill	Good logical and mathematical skill, understanding of social political and natural environment, good in collecting and organising information, communication and presentation	Exercise management and supervision in the context of work/study having unpredictable changes;	8

	<p>skill.</p> <p>They need to be able to collaborate with both your clients, colleagues & show their presence leadership. They are intrigued by new ideas and flexible to apply them for toughest challenge</p>	responsible for the work of others.	
Responsibility	<p>Full responsible for making decision of technical activities and development of self and others. Making in complex technical activities and unpredictable study or work situations.</p> <p>Technology in order to meet their business objectives or overcome problems. They work to improve the structure & efficiency of IT Systems in various organisations.</p>		8

SECTION 4

EVIDENCE OF RECOGNITION OR PROGRESSION

What steps have been taken in the design of this or other qualifications to ensure that there is a clear path to other qualifications in this sector?

This qualification comprises of Technical, Analytic and Problem solving skills and can be linked to any qualification higher than this one, existing or to come.

SECTION 5

EVIDENCE OF INTERNATIONAL COMPARABILITY

List any comparisons which have been established.

Refer Annexure V

Detailed Curriculum

Name of Unit of Qualification : C0-R4.B1: ELEMENTS OF MATHEMATICAL SCIENCES

Duration : 120 Hrs.

Topic	Contents	Hrs.
Linear Algebra: Matrices, Vectors, Determinants	Basic concepts, Matrix addition, Scalar multiplication, Matrix multiplication, Linear systems of equations-Gauss elimination, Rank of a matrix, Vectors, Dot product, Cross product, Linear independence, Solutions of linear systems: Existence, Uniqueness, Determinants-Cramer's rule, Inverse of a matrix, Gauss Jordan elimination, Eigen values, Eigen vector, Some application of Eigen value problems.	12
Calculus: Differential and Integral Calculus	Binomial Theorem, Trigonometric functions e^x $\log x$ and their graphs, Real numbers and real line, Functions. Limit and Continuity: L'Hospital rule, Continuity, Tangent lines, Differentiation rules, Implicit differentiation, Mean value Theorem, Extreme values, Asymptotes. Integration: Indefinite integrals, Integration by parts, Partial Fractions, Integration by substitution, Definite Integrals, Fundamentals theorem of calculus(statement only), Properties of integrals, area, Evaluation of definite integrals.	12
Analytical Geometry	Equation of a line and circle, Parameterized curves, Polar coordinates: Conic sections and Quadratic equations, Classifying conics.	06
Infinite Series	Limit of sequences and series, Theorem for calculating limits, Infinite series, Integral test, Ratio test, Comparison test, Alternate series, Taylor and McLaurin series.	06
Probability Theory and Distributions	Rules of probability, Conditional probability, Independent events, Bayes Theorem, Continuous and Discrete random variables, Expected value of a random variable, Moment and moment generating functions,	12

	Product moment, Covariance, Probability Distributions – Bernoulli, Binomial, Poisson, Geometric, Uniform, Exponential, Normal and Bivariate normal distribution.	
Statistics	Introduction, Random sampling, Estimation of parameters, Confidence intervals, Testing of hypothesis, Goodness of Fit, Chi-square test, Regression analysis.	12
Practical/Tutorials		60

Text books:

1. E Kreyszig, “Advanced Engineering Mathematics”, 10th Ed., 2011, Wiley Publication.
2. G. B. Thomas and R. L. Finney, “Calculus and Analytical Geometry”, 9th Edition, 2002, Pearson Education Asia
3. Sheldon Ross, A First Course in Probability, 8th edition, 2009, Pearson Education

Reference Books:

1. H. Anton, I. Bivens, S. Davis, Calculus: Early Transcendental, 9th Edition, 2010, Wiley
(*) Latest edition of the books need to be procured.

Detailed Curriculum

Name of Unit of Qualification : C0-R4.B2: OPERATING SYSTEM

Duration : 120 Hrs.

Topic	Contents	Hrs.
Overview	<p>Introduction: Operating Systems, Multi programmed batched system, Time sorting systems, Parallel and Distributed Systems, Real Time Systems, Computer System Structures :I/O Structure, Storage Structure, Storage Hierarchy, hardware, Protection, General System Architecture.</p> <p>Services: User Interface Services, Graphics and Multimedia Services, Messaging and Collaboration, Network basics, Web Services</p> <p>Operating System Structures: System Components, Operating System Service, System Calls, System programmes, System Structure, System Design and Implementation, System Generation, Virtual machines and Hypervisor.</p>	08
Process Management	<p>Processes: Process Concept, Process Scheduling, Operation on Processes, Cooperating Process, Interprocess Communication, Symmetric vs. asymmetric multiprocessing, Background Process.</p> <p>CPU Scheduling: Scheduling Criteria, Scheduling Algorithms, Multiple Processor Scheduling, Real Time Scheduling, Algorithms Evaluation, Thread Scheduling, System Jobs.</p> <p>Process Synchronization: The Critical Section Problem, Synchronization Hardware, Semaphores, Classical Problems of Synchronization, Critical Regions, Monitors.</p> <p>Deadlocks: Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Deletion, Recovery from Deadlock, Combined approach to Deadlock Handling.</p>	10
Storage Management	<p>Memory management: Logical versus Physical Address Space Swapping, Contiguous Allocation, paging, Segmentation, Segmentation with paging.</p>	10

	<p>Virtual memory: Demand Paging, Performance of Demand paging, Page Replacement Algorithms, Thrashing, Demand Segmentation.</p> <p>File System Interface: Access Methods, Directory Structure, Protection, Consistency Semantics, Partitions, Simple Volumes, Shadow Volumes, Virtual Disks, Bitlocker.</p> <p>File System Implementation: File System Structure, Allocation Methods, Free Space management, Directory Implementation, Efficiency and Performance, Recovery.</p>	
I/O Systems	<p>I/O Systems: I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to hardware Operations, Performance, Synchronous I/O and Asynchronous I/O, File Caching.</p> <p>Secondary Storage Structure: Disk Structure, Disk Scheduling, Disk management, Swap-Space management, Disk Reliability, Stable Storage Implementation.</p> <p>Tertiary-Storage Structure: Tertiary-Storage Devices, Operating-System Jobs, Performance Issues.</p> <p>File System: File System Formats (CDFS, FAT, exFAT etc.), Kernel Mode and User Mode Driver Framework.</p>	08
Distributed Systems	<p>Network Structure: Topology, Network Types, Communication, Design Strategies.</p> <p>Distributed System Structures: Network Operating Systems, Distributed Operating Systems, Remote Services, Robustness, Design Issues.</p> <p>Distributed File Systems: naming and Transparency, Remote File Access, Stateful versus Stateless Service, File Replication.</p> <p>Distributed Coordination: Event Ordering, Mutual Exclusion, Atomicity, Concurrency Control, Deadlock Handling, Election Algorithms, Reaching Agreement</p>	10
Protection & Security	<p>Protection: Goals of Protection, Domain of Protection, Access matrix, Implementation of Access matrix, Revocation of Access Rights.</p> <p>Security: The Security Problem, Authentication, One-Time Passwords, Program Threats, System Threats, Threat Monitoring, Encryption, Computer-Security Classification, Common Criteria, VPN, Protocol Security, Access Checks (ACL, DACLs), Auditing,</p>	08

	Policy Management, User Account Controls(UAC).	
Case Studies	The Unix System, The Linux System, Windows Server.	06
Practical/Tutorials		60

Text books:

1. Silberschatz Galvin, "Operating System Concepts", 1999, Addison-Wesley Longman.
2. Andrew S. Tanenbaum, Albert S. Woodhull, "Operating Systems: Design & Implementation" 2002, Pearson Education Asia.
3. Mark E. Russinovich and David A. Solomon, "Windows Internals 5th Edition" June 2009: Microsoft Press.

Reference Books:

1. D.M. Dhamdhere, "Operating Systems: A Concept based Approach", 2002, Tata McGraw Hill Publishing Company.
2. A.S. Godbole, "Operating Systems", Tata McGraw Hill, 2002.
3. Stephen G. Kochan, Patrick Wood, "Unix Shell Programming" SAMS Publishing 2007, Third Edition, Pearson Education.
4. Richard L. Petersen, "LINUX: The Complete Reference "fifth edition, Tata McGraw Hill, 2006.
5. Kate Wrightson, Joe Merlino, "Introduction to Unix", McGrawHill Irwin, 2003.

Name of Unit of Qualification

C0-R4.B3: DATA STRUCTURE THROUGH JAVA

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction	Algorithms, Data Structures, Summation Formulas and properties, Sets, Relations, Functions, Graphs, Trees, Counting, Probability Concepts	2
Introduction to Object Oriented Programming and Java	Object-Oriented Design Principles, Encapsulation, Inheritance, Polymorphism, Basic goals and concepts of Java, Programming Skills, Xtreme Programming, debugging, testing, Application of OO concepts.	3
Performance Analysis Techniques	Space Complexity, Time Complexity, Running Time, Pseudo-Code, Quick Mathematical Review, Analysis of Algorithms, Asymptotic Notation, Asymptotic Analysis.	3
Elementary Data Structures	Introduction of Stack, Queue and Linked List, Application of Stacks and Queue, Representation of Queue and its types, Representation of Linked List and its types, Priority Queue, Implementing Objects, Java Code for Linked List, Stack, Queue.	4
Recursion	Characteristic of recursive Methods, Efficiency of Recursive methods, Tower of Hanoi Example, Java code for Tower of Hanoi, Eliminating Recursion, Applications of Recursion.	4
Trees	The Tree Abstract Data Type, Basic Algorithms on Trees, Types of trees and algorithms, Binary Search Tree, Red Black Tree, B-Tree, AVL Trees, Java Code for Binary Search Tree, Red Black Tree, B- Tree and AVL Tree	7
Graphs	The Graph Abstract Data Type, Data Structures for Graphs, Graph Traversal: BFS	3

	and DFS of Directed and Undirected Graph, Connected Components, Spanning Trees, Bi-connected Components and DFS. Java Code for DFS and BFS.	
Strings	The String Abstract Data Type, Brute-Force String Pattern Matching, Regular Expression Pattern Matching, Tries.	10
Sorting and Searching Methods	Introduction to Sorting Techniques: Insertion Sort, Selection Sort, Bubble Sort, Heap Sort, Quick Sort, Merge Sort, Radix Sort, Analysis of Efficiency and Complexity of Sorting of various cases (Best, Average and Worst); implementation via Java programs.	12
Practicals/Tutorials		60

Text books:

1. Jean-Paul Tremblay and Paul G, “An Introduction to Data Structures with Applications”, Sorenson Publisher – Tata McGraw Hill.
2. Wiley Higher Education, “Data Structures and Algorithms in Java”, 3rd Edition, John Wiley & Sons.

Reference Books:

1. Michael T. Goodrich and Robert Tamassia, “Data Structures and Algorithms in Java”, John Wiley Publication
2. Robert Lafore, “Data Structures and Algorithms in Java”, 2nd Edition, Pearson Education.

Name of Unit of Qualification :C0-R4.B4: COMPUTER SYSTEM ARCHITECTURE

Duration : 60 Hours

Learning Outcome	Topics	Hours
Introduction to Computer Arithmetic	Decimal Representation, Complements, Fixed point representation, Addition, Subtraction with Signed-magnitude, Signed 2's Complement method, Booth Multiplication Algorithm, Array Multiplier, Division Algorithm, hardware Implementation, Floating Point Arithmetic operations.	8
Register Transfer Language	Register Transfer, Bus and Memory transfer, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic logic and shift	6
Instruction Set Design	Assembly/machine language, Von Neumann machine cycle, Microprogramming/firmware, Memory addressing, Classifying instruction set architectures, Computer Registers, General Registers Organization, Computer Instructions, Timing and control, Instruction Cycle, Memory Reference Instructions, Input-output and interrupt, Instruction Format, Addressing modes, Data transfer and manipulation, program Control, RISC and CISC.	12
Pipelining	General considerations, Comparison of pipelined and nonpipelined computers, Instruction and arithmetic pipelines – examples, Structural hazards and data dependencies, Branch delay and multicycle instructions, Superscalar computers.	6
Programming the Basic Computer	Introduction to Machine Language, Assembly language, Program loops, Programming arithmetic and logic operations, Subroutines, Input-output programming.	6
I/O Fundamentals	Typical I/O devices, Programmed I/O, Peripherals Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of transfer, Priority Interrupt, DMA, I/O Processor, CPU-IOP Communication, Serial Communication, Interrupts and DMA, I/O bus operation, TRAP instruction, Role of OS.	8
Memory Organization	Memory Hierarchy, Main memory, Auxiliary Memory, Associative memory, Cache memory, Virtual Memory, Memory management hardware, Case study of PC	8

	architecture and hardware, bus and interrupts, DMA control, Different types of bus, ISA, EISA.	
Multiprocessor and Multiple Computers	SISD, SIMD and MIMD architectures, Centralized and distributed shared memory-architectures.	6
Practical/Tutorials		60

Text Books:

1. Morris Mano, "Computer System Architecture", Prentice Hall of India Edition.
2. Pal Chaudhary, "Computer Organization and Design", Prentice Hall of India

Reference Books:

1. David A Patterson and John L Hennessy, "Computer Architecture: A Quantitative Approach" 4th edition, Morgan Kaufmann Publishers
2. B Govindarajalu, "IBM PC and clones", Tata McGraw-Hill
3. P.V.S. Rao, "Perspective in Computer Architecture", Prentice Hall of India
4. M.R. Bhujade, "Digital Computer Design Principles", Prentice Hall of India
5. Cook and White, "Computer Peripherals", Edward Arnold

Name of Unit of Qualification

: C1-R4: ADVANCED COMPUTER GRAPHICS

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Basic Background	Two Dimensional Geometric Transformations. Clipping: Point clipping, Line clipping, Polygon clipping, Text clipping, Logical Classification of input devices, Different input modes, Interactive picture-construction techniques, Three Dimensional Geometric Transformations.	7
3D Viewing	Viewing pipeline, Viewing coordinates, Parallel and Perspective Projections, View volumes and Projection transformations, Clipping.	7
Representing Curves and Surfaces	Polygon Meshes: Representing polygon Meshes, Consistency of polygon-mesh representations, Plane equations. Parametric Cubic Curves: Hermite curves, Bezier curves, Uniform nonrational B-splines, Subdividing Curves, Drawing curves, Comparison of the cubic curves, Parametric Bicubic surfaces.	10
Solid Modeling	Representation of Solids, Primitive Instancing, Sweep representations, Boundary representations, Spatial-partitioning representations, Constructive solid geometry methods, Octrees, Binary, Space Partitioning trees.	6
Visual Surface Determination	Introduction, Techniques for efficient visible-surface algorithms, Coherence, The Perspective Transformation, Extents and bounding volumes, Back-face culling, Algorithms for visible-line determination: Appel's Algorithm, Z-Buffer Algorithm, Depth-sort Algorithm, Binary Space Partitioning Trees, Representing 3D data using Octrees, Boolean Operations on Octrees, Visible Surface ray tracing.	10
Illumination Models and Surface-Rendering Methods	Basic Illumination models: Diffuse reflection, Specular reflection and Phong model, Warn model, Intensity attenuation, color considerations, Transparency, Shadows, Displaying light	

	intensities, Halftone patterns and Dithering techniques, Polygon-rendering methods, Gouraud and Phong Shading, Ray Tracing methods, Problems with interpolated shading, Bump mapping.	
Color Models	Properties of light, Intuitive color concepts, RGB color model, YIQ color model, CMY color model, HSV color model, Conversion between HSV and RGB models, HLS color model.	6
Introduction to Animation	Introduction, Methods of controlling Animation, basic rules of Animation, Problems peculiar to animation, Raster animations, Computer-Animation languages, Key-frame systems, Motion specifications.	5
Practical/Tutorials		60

Text Books:

1. James D. Foley, Andries Van dam, Steven K. Feiner & John F. Hughes, “Computer Graphics – Principles and Practices”, 2nd Edition in C, 2005
2. Donald Hearn and M Pauline Baker, “Computer Graphics”, 2nd Edition, 2003, Prentice Hall of India.

Reference Books:

1. Woo, Neider, Davis, Shreiner, “Open GL Programming Guide”, 3rd edition, 2000, Pearson Education.
2. David F. Rogers, “Procedural Elements for Computer Graphics”, 2nd Edition, Tata-McGraw Hill.
3. Zhigang Xiang and Roy Plastock, “Computer Graphics”, 2nd Edition, 2002, Tata McGraw-Hill Edition.

Name of Unit of Qualification

: C2-R4: ADVANCED COMPUTER NETWORKS

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Networking Concepts	Layered operation, Protocol Suites, Flow and Congestion Control, Multiplexing, Synchronizati	06
Performance Models	Queuing Systems-M/M/S/K Queues, Burke's Theorem, M/G/1 Queues, Delay in synchronous and asynchronous time-division multiplexing. Network of Queues: Jackson's Theorem, Closed Queuing Networks.	10
Multiple Access Networks	Review of ALOHs and CSMA, Stability in Slotted ALOHA-Pseudo Bayesian Algorithm, Splitting Algorithms – Tree and First Come First Serve FCFS Spitting.	06
Cell Relay and Asynchronous Transfer Mode(ATM)	ATM features, Protocol Architecture, Virtual Channel and Virtual Paths, ATM Cells – Structure at UNI and NNI, Generic Flow Control, Header Error Control, ATM Services – CBR,VBR,UBR,ABR. ATM Adaptation Layers-AAL1, AAL2, AAL3/4, AAL5. ATM Traffic Control: Connection Admission Control (CAC), Usage Parameter Control (UPC)-Virtual Scheduling Algorithm, Continuous State Leaky Bucket Algorithm. Traffic Shaping.	10
IP Networks	Limitations of current IP Networks, Internet Protocol Version 6 (IPv6) features, IPv6 Extension Header, Quality of Service in IP: Integrated Services Architecture (ISA), Processor Sharing, Weighted Fair Queuing (WFQ), Random Early detection (RED), Differentiated Services.	07

Multicast and Internetworking	The Multicast Backbone (MBONE), Link State Multicast, Distance Vector Multicast, Reverse Path Broadcast, Reverse Path Multicast (RPM), Protocol Independent Multicast (PIM), Multiprotocol Label switching (MPLS)-Destination Based Forwarding, Explicit Routing, Virtual Private Networks (VPNs) and Tunnels.	07
End-to-End Protocols	Transmission Control Protocol (TCP) and User Datagram Protocol (UDP), TCP Connection Establishment, TCP Flow Control, TCP Congestion Control – Jacobson’s and Karn’s Algorithms, Window Management. TCP Extensions. Remote Procedure Call (RPC). Bulk Transfer (BLAST)	07
Multimedia Networking	Requirements on Internet. Streaming Audio and Video – Access through Web Server, Real-Time Streaming Protocol (RTSP). Voice over IP (VoIP) and Internet Phone-Packet Loss, End-to-End Delay, Delay Jitter, Fixed and Adaptive Play-out, RTP, RTCP and SIP protocols	07
Practicals/Tutorials		60

Text Books:

1. Bertsekas and Gallager, “Data Networks”. 2nd Ed., Prectice Hall India.
2. Stallings, “High-Speed Networks and Internet”, 2nd Ed., Pearson Education.
3. Peterson and Davie,”Computer Networks-A Systems Approach”, 3rd Ed., Elsevier (India)
4. Kurose and Ross, “Computer Networking”, 3rd Ed., Pearson Education.

Reference Books:

1. 1. Robertazzi, “Computer Networks and Systems”, 3rd Ed., Springer (India)
2. Tanenbaum, “Computer Networks”, 4th Ed., Prentice-Hall India
3. Huber, Handel and Schroder, “ATM Networks – Concepts, Protocols, Applications”, 3rd Ed., Pearson Education.

Name of Unit of Qualification

: C3-R4: MATHEMATICAL METHODS FOR COMPUTING

Duration

: 120 Hours

Performance Criteria(OUTCO ME) No.	Contents	Hrs.
Probability and Information theory	Axioms and Probability, Bayes' Formula, Expectations of Random Variables, Jointly Distributed Random Variables, Conditional Expectation, Bivariate and multivariate Gaussian distribution, some applications- A list model, A random graph. Limit theorems, random number Generation, Simulating continuous random variables, Monte Carlo integration. Information theory, Measure of uncertainty, Shannon's Measure, Entropy, Joint and Conditional Entropies, Mutual Information, Kullback-Leibler Directed Divergence, Coding theory and Entropy.	12
Stochastic Processes	Stochastic Processes and specifications, Stationary Processes, Markov Chains, Markov processes, Poisson Process, Renewal process, Birth and death Process, Random Walk, Brownian motion.	12
Queuing Theory and Performance Evaluation	The M/M/1 Queueing System, State dependent M/M/1 Queueing System, M/M/1/N : Finite buffer case, M/M/∞ Queueing system: Infinite number of servers, The M/G/1 Queueing system, Network of Queues, Open networks and Closed networks.	12
Optimization	Modeling with linear programming, Simplex Method, Dual Problem, Integer Linear programming [Branch and bound algorithm], Deterministic dynamic programming [forward and backward recursions], Introduction to nonlinear programming Karush-Kuhn-Tucker (KKT) condition.	14
Laplace and Fourier Transforms	Laplace transform, Inverse transform, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Convolution and Integral equations. Fourier series, Integrals, and Transforms: Periodic Functions, Trigonometric Series, Fourier series, Forced Oscillations, Fourier transforms.	10
Practicals/Tutorials		60

Text Books:

1. K.S.Trivedi, "Probability and Statistics with Reliability, Queuing, and Computer Science Applications", 2nd Edition, John Wiley, 2008.
2. E.K.P.Chong and S.H.Zak, "An Introduction to Optimization", 3rd Edition, 2008, John Wiley.
3. S.Ross, "A First Course in Probability", 6th Edition, Pearson, 2010.
4. E.Kreyszig, "Advanced Engineering Mathematics," 10th Edition, 2011, Wiley

Reference Books:

- 1.T.G.Robertazzi, "Computer Networks and systems:Queueing Theory and performance Evaluation", 3rd Edition, Springer, 2002
- 2.R.K.Jain and S.R.K.Iyengar, "Advanced Engineering Mathematics", Alpha Science International, 2007.
- 3.J.C.A Van der Lubbe, "Information Theory", Cambridge, 1997.
4. H.A.Taha, "Operations Research:An Introduction", 8th Edition, Pearson Education, 2006..

Name of Unit of Qualification

: C4-R4:ADVANCED ALGORITHMS

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction	Mathematics for Algorithmic, Sets , Functions and Relations, Vectors and Matrices , Linear Inequalities and Linear Equations, Review of basic concepts; Worst case and average case analysis: big oh; small oh, omega and theta notations, Solving recurrence equations	06
Greedy Algorithms	Knapsack Problem , O-I Knapsack , Fractional Knapsack , Activity Selection Problem , Huffman's Codes , Minimum Spanning Tree , Kruskal's Algorithm , Prim's Algorithm , Dijkstra's Algorithm.	06
Divide & Conquer Algorithms	Multiplying large integers, Binary Search, Finding Median, Quick Sort and Matrix Multiplication.	06
Dynamic Programming Algorithms	Making Change, Principle of optimality, Knapsack Problem, Shortest Path, Matrix Chain Multiplication, Activity Selection Problem DP Solution.	06
Amortized Analysis	Aggregate Method, Accounting Method, Potential Method, Dynamic Table	04
Graph Algorithms	Breadth First Search (BFS), Depth First Search (DFS), Branch and Bound, Topological Sort, Strongly Connected Components, Euler Tour, Generic Minimum Spanning Tree, Bellman-Ford Algorithm, Matching, Incremental Design, Closest pair problem.	08
String Matching	Naïve String Matching, Knuth-Morris-Pratt Algorithm, Boyer-Moore Algorithm, Applications in Bioinformatics.	06
Sorting	Bubble Sort, Insertion Sort, Selection Sort, Shell Sort, faster Methods-Tree, Heap Sort, Merge Sort, Quick Sort, Linear-Time Sorting-Counting (Enumeration) Sort, Radix Sort, Bucket	06
Computational Complexity	Information-Theoretic Argument, Adversary Argument, P and NP, NP-Completeness and Reduction, Primality tests, Quadratic residues, Applications to cryptography, Lower bound theory, Information theoretic bounds, Adversary arguments	06

	and NP completeness.	
Approximate Algorithms	Vertex Cover, The Traveling Salesman Problem, Approximate algorithms, Scheduling problems, Set cover problem, Bin packing problem, Polynomial time approximate schemes, basics of parallel algorithms, Flynn's classification, SIMD algorithms for simple problems, List ranking, Basics of randomized algorithms, GCD algorithm.	06
Practicals/Tutorials		60

Text Books:

1. T H Corman et al, "Introduction to Algorithms", Pearson Education, 2001.
2. Aho, Hopcroft, Ullman, "The Design and analysis of computer algorithms", Pearson Education.
- 3.

Reference Books.

1. M T Goodrich, R Tamassia, "Algorithm Design- Foundations, Analysis & internet Examples", John Wiley & Sons, 2002.
2. Gilles Brassard and Paul Bratley, "Fundamentals of Algorithms", Prentice Hall India, 2004.

Name of Unit of Qualification

: C5-R4:DATA WAREHOUSING AND DATA MINING

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction and Background	An introduction to multidisciplinary field of data mining, Discussion on the evolutionary path of database technology that has led to the need for data warehousing and data mining, different kind of data on which data mining applied, classification of data mining system, Major issues in Data mining, Stress on important of its application potential.	03
Data Pre-processing	Why preprocess the data?, descriptive data summarization, .Data cleaning, data integration and transformation, data reduction, and data discretization and concept hierarchy generation	08
Data warehousing and OLAP Technology	Data warehouse, multi dimensional model, Data Warehouse Architecture and implementation, OLAP overview and OLAP operators, Data cube constructions.	08
Data Cube Computation and Data Generalization	Efficient methods for data cube computation – A road map for materialization of different kinds of cube, multi way array aggregation for full cube computation, Computing iceberg queries from apex cuboids, star cubing, pre-computing shell fragments for fast high dimensional OLAP and computing cubes with complex iceberg conditions. Data Generalization and Summarization based characterization: Attribute Oriented Induction (AOI) – Efficient implementation of AOI, Analytical Characterization, Mining class comparison: Discriminating between Different classes, Mining Descriptive Measures in Large database.	08
Mining frequent Patterns, Associations and Correlations	Basic concepts and a road map for Association rule mining, efficient and scalable frequent item set mining methods, mining various kinds of association rules, from association mining to correlation analysis, constraint based association rule mining.	08
Classification and Predictions	Issues regarding classification and predication, Different classification methods including Decision tree induction – Bayesian Classification, Neural network technology, K- Nearest Neighbour	08

	Classifier- Case-based Reasoning - Fuzzy set theory - genetic algorithm, Prediction: Linear and Multiple Regression – Nonlinear Regression – Other Regression Models, Classifier Accuracy. Prediction, accuracy and error measures evaluating accuracy of a classifier , model selection	
Cluster Analysis	Types of data in cluster analysis, Partition based Clustering, Hierarchical Clustering, Density based Clustering, Grid based Clustering, Model based Clustering, Discussion on scalability of clustering algorithm, Outlier analysis, Parallel approaches to clustering and outlier analysis	08
Mining Stream, Time Series and Sequence Data	Mining data streams, mining time-series data, mining sequence patterns in transactional databases and mining sequence patterns in biological data	06
Application of Data Warehousing and Data Mining	Exploration of web sites on data warehousing and data mining application including bibliography databases, Corporate Houses and Research labs. Use of data mining packages and data warehousing packages, e.g. SAS, IBM, excel miner tools.	03
Practicals/Tutorials		60

Text Books:

1. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, second edition, 2006.
2. Margaret Dunham, “Data Mining: Introductory and Advanced Topics”, Prentice Hall India
3. Arun K Pujari, “Data Mining Techniques”, Orient Longman Publishers

Reference Books

1. Tom Mitchell, “Machine Learning”, Tata McGraw-Hill.
- 2.S.M. Weiss and N Indurkha, “Predictive Data Mining”, Morgan Kaufmann Publishers
3. M.Jarke, M Lenzerni and Y Vassiliou and P.Vassiladis, “Fundamentals of Data Warehouses”, Springer-Verlag New York, 1st edition, 200

Name of Unit of Qualification

: C6-R4: MULTIMEDIA SYSTEMS

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction	Concept of Temporal and Non-Temporal Data, Basic Characteristic of Non-Temporal Media; Images, Graphics, Text, Basic characteristic of Temporal Media; Video, audio and animation, Hypertext and Hypermedia, Presentation: Synchronization, Events, Scripts and Interactivity. Introduction to Authoring Systems.	08
Compression of Multimedia Data	Basic concept of compression, Still image compression: JPEG, Features of JPEG 2000, Video compression: MPEG-1 &2 compression Schemes, MPEG-4 Natural video compression. Audio Compression; Introduction to Speech and Audio Compression, MP3 Compression Scheme. Compression of Synthetic Graphic Objects	12
Multimedia Systems	General Purpose Architecture for Multimedia Support: Introduction to Multimedia PC/ Workstation Architecture, Characteristics of MMX instruction set, I/O System: Overview of USB port and IEEE 1394 interface, Operating System Support for Multimedia Data: Resource Scheduling with real-time considerations, File System, I/O Device Management	08
Delivery of Multimedia Data	Network and Transport Protocols for Multimedia Data QoS issues, RTP and RSVP Video-conferencing and video-conferencing standards Overview of Voice/ Video over IP	08
Multimedia Information Management	Multimedia Database Design Content Based Information Retrieval: Image Retrieval, Video Retrieval, Overview of MPEG-7, Design of Video-On Demand Systems	08
Multimedia Programming Tagging (SMIL)	Introduction to SMIL, Running SMIL applications, SMIL Authoring.	02
Introduction to MIDI (Musical Instrument Digital Interface)	Components of MIDI, Hardware Aspects to MIDI, MIDI Messages, General MIDI, Digital Audio and MIDI	02

Virtual Reality	Introduction to Virtual Reality and Virtual Reality Systems Related Technologies: Tele-operation and Augmented Reality Systems Interface to the Virtual World- Input; Head and hand trackers, data globes, haptic input devices Interface to the virtual world- Output; Stereo display, head-mounted displays, auto-stereoscopic displays, holographic displays, haptic and force feedback VRML Programming; Modeling objects and virtual environments Domain Dependent applications : Medical, Visualization, Entertainment etc.	12
Practicals/Tutorials		60

Text Books:

1. Ralf Steinmetz and Llara Nahrstedt, "Multimedia: Computing, Communications & Applications", Pearson Education
2. P.K. Andleigh and K.Thakrar, "Multimedia Systems Design" , Prentice Hall India, 1996
3. John Vince, "Virtual Reality Systems"., Thomson training & Simulation Ltd.
4. Fred Halsall, "Multimedia Communications", Addison Wesley Longman Publishing Co., 2000.

Reference Books

1. Tay Vaughan, "Multimedia: Making it work", seventh edition, McGraw-Hill Publication
2. Jed hartman, Josie Wernecke, Rick Carey, "Multimedia: Concepts and Practice"
3. The VRML 2.0 Handbook, "Building Moving Worlds on the Web", Addison Wesley Longman Publishing Co.
4. William Sherman, Alan Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann Publishers, 2002.

Name of Unit of Qualification

: C7-R4: DIGITAL IMAGE PROCESSING & COMPUTER VISION

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction to Image Processing & Computer Vision	Fundamentals, Purpose, Application, Image processing system components, image sensing & Acquisition, sampling & Quantization. Neighbors of a pixel adjacency connectivity, regions & boundaries, Distance Measures, stereo vision.	7
Image Formation	Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, stereo and multi view geometry, Binocular imaging systems	5
Image Enhancement & Restoration	Spatial filtering: Intensity transformations – piece-wise linear transformations, bit plane slicing, histogram equalization, smoothing filtering masks, sharpening filters – gradient operators and Laplacian filters. Frequency domain filtering: Image sampling, 2D Discrete Fourier Transform, lowpass filtering- ideal and Gaussian, highpass filtering- ideal, Gaussian, Laplacian. Noise Models. Mean, median and min-max filters. Minimum mean square error filter.	10
Colour Image Processing	Colour models, pseudocolour, image processing, colour transformation, segmentation.	5
Wavelets and Multi resolution Processing	Image pyramids, subband coding, Harr transform, multi resolution expansions, discrete and continuous wavelet transforms	6
Image Compression	Fundamentals, Basic compression methods – Huffman, Arithmetic, LZW, run length coding schemes, Error free & Lossy compression, Standards: JPEG, JBIG	5
Edge and Boundary Detection	Edge detection, boundary detection, edge detection performance, boundary detection performance.	4
Morphological Image Processing	Erosion and dilation, opening and closing, boundary extraction, hole filling.	6

Motion Estimation, Detection & Tracking	Regularization theory, optical computation, Motion estimation, Structure from motion.	6
Shape Representation & Reconstruction	Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi-resolution analysis.	6
Practicals/Tutorials		60

Text Books:

1. Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education.
2. D.Forsyth, J Ponce, "Computer Vision – A Modern Approach", Prentice Hall, India

Reference Books

1. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall India
E.Trucco, A Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall.

Name of Unit of Qualification

: C8-R4: INFORMATION SECURITY

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction to Cryptography	Terminology, Security Aspects, Attack Models, Classical Cryptography, Shift Cipher, Substitution Cipher, Vigenere Cipher, Basic Cryptanalysis	06
Mathematics of Cryptography	Groups, Rings, and Fields, Integer Arithmetic, Modular Arithmetic, The Euclidean Algorithm, Finite Fields of The Form $GF(p)$, Polynomial Arithmetic, Finite Fields Of the Form $GF(2^n)$, Linear Congruence	04
Introduction to Number Theory	Prime Numbers, Primality Testing, Factorization, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms	06
Conventional Encryption	Attacks on Encryption Schemes, Perfect Security, Cipher Machines, Modes of Operation (ECB, CBC, CFB, OFB) , Multiple Encryption , DES, Triple-DES, AES,RC4 Stream Cipher , Attacks on DES.	08
Pseudo-random Number Generators (PRNGs)	Random and Pseudorandom Numbers, Next-bit Test, Removing Biases, ANSI X9.17 Generator Blum-Blum-Shub Generator, Statistical Tests.	08
Hash Functions and MAC	Standard hashes (MD5, SHA-1, SHA-256/384/512, RIPEMD-160), Birthday Attack , Collision-freeness and recent attacks , Message Authentication Code (MAC) Algorithms , Authenticated Encryption	10
Key Establishment and Public-key Cryptography	Key Management, Diffie-Hellman Key Exchange, Attacks on Diffie Hellman, RSA, , Attacks on RSA , ElGamal, Attacks on ElGamal , Semantic Security and Chosen-ciphertext Security , Provably Secure Schemes	10
Integrity and Digital Signature	Message Integrity, Digital Signature, Authentication Protocol, Digital Signature Standards, Attacks on Digital Signature, Variation and Applications	08
Practicals/Tutorials		60

Text Books:

1. William Stallings, “Cryptography and Network Security, Principles and Practice”, Prentice Hall India.
2. Behrouz A Forouzan, “Cryptography & Network Security”, Tata McGraw-Hill Publications

Name of Unit of Qualification

: C9-R4:SOFT COMPUTING

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction to Soft Computing	Hard Computing, Soft Computing, Features of Soft Computing, Constituents of Soft Computing, Applications of Soft Computing Crisp Logic, Fuzzy Logic (FL), Rough Logic and Systems based on it Probabilistic Theory, Genetic Algorithms (GA), Artificial Neural Network (ANN).	06
Introduction to Genetic Algorithm	Introduction to Genetic Algorithms - Definition of GA - Description of Terminology/Vocabulary of GA - Importance and Goal of Traditional Optimization Methods - Classification of Search Techniques - Introduction to Hill climbing - Simulated annealing – Decision Tree - Difference between Genetic Algorithms and Traditional Methods - Simple Genetic Algorithm Examples	06
Genetic Modeling	Offspring – Encoding - Fitness Function – Reproduction – Crossover - Inverse and Deletion - Mutation Operator - Generational Cycle – Convergences - Application	08
Regression and Optimization	Least Square Methods for System Identification System Identification Introduction, Basics of Matrix Manipulation and Least Squares Estimators, Recursive Least Squares Estimators, Introduction to Derivative Based Optimization, Introduction to Derivative Free Optimization	08
Neuro-Fuzzy Modeling	Introduction to Neuro-Fuzzy Modeling, Approaches of Neuro-Fuzzy Systems, Fuzzy Neural approach, Cooperative Neuro-Fuzzy Approach, Concurrent Neuro-Fuzzy Approach, Hybrid Neuro-Fuzzy Approach, Applications of Cooperative Neuro-Fuzzy Systems	08
Advanced Neuro-Fuzzy Modeling	Framework of Adaptive Neuro-Fuzzy Inference Systems(ANFIS), Hybrid Learning Algorithm, Learning Methods, Universal Approximation, Generalized Adaptive Neuro-Fuzzy Inference Systems(ANFIS), Neuro-Fuzzy Spectrum, Analysis of Adaptive Learning Capability, Rule extraction,	08

	and Evolution, Evolution of Antecedents, Evolution of Consequents, Evolving Partitions.	
Neuro-Fuzzy Control	Introduction, Feedback control Systems, Neuro-Fuzzy Control, Expert Control, Inverse Learning, Specialized Learning, Back-propagation through Time and Real Time Recurrent Learning, Reinforcement Learning Control, Introduction to Fuzzy Filtered Neural Network	08
Other Hybrid System	Genetic–Fuzzy Systems, Genetic Algorithms Controlled by Fuzzy Logic, Fuzzy Evolutionary Systems, Evolving Knowledge Base and Rule Sets, Neuro-Genetic Systems, Neural Network Weight Training, Evolving Neural Nets, Genetic Fuzzy Neural Network	08
Practicals/Tutorials		60

Text Books:

1. Jang J S R, Sun C T, Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education Edition, 1997, Reprint 2007
2. Akerker and Sajja, MS and Jones and Bartlett, MA, USA, “Knowledge-Based Systems”, 2009
3. Ian Cloete and Jacek Zurada, “Knowledge Based Neuro-Computing” University Press, Massachusetts Institute of Technology, USA, 2002
4. Oscar Cordon, Francisco Herrera, Frank Hoffmann, Luis Magdalena, “Genetic Fuzzy Systems”, Word Scientific Publishing Ltd. , 2001

Reference Books.

1. Partihar D K, “Soft Computing” , Narosa Publication, 2008
2. Sivanandam S N and Deepa S N, “Principles of Soft Computing”, Wiley India Edition, 2007
3. Rushell and Norvig, “Modern Approach to Artificial Intelligence”, Prentice Hall of India Ltd., 2006
4. Rich and Knight, “Artificial Intelligence”, Tata McGraw Hill Publishing Co. Ltd. 21st Indian Reprint, 2001
5. Anupam Shukla, Ritu Kala, Rahul Kala, “Real Life Applications of Soft Computing”, CRC Press.

Name of Unit of Qualification

: C10-R4:SOFTWARE SYSTEMS

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Basic of Software Engineering and Study of Different Life cycle Models	Software Characteristics, Components, Applications, Layered Technologies, Processes, Product, Methods and Tools. Software Engineering Concepts, S/W Engineering Development Activities, Software Reusability and Re-Engineering. Generic View of Software Engineering, Waterfall, Prototype, Incremental, Spiral and Concurrent, Development Model.	06
Requirements & Specification	Problem Recognition, Evaluation And Synthesis, Modeling, Specifications And Review Techniques Requirements engineering; analysis; system model; software prototyping; formal specification; algebraic specification; model based specification	06
Design Concept and Methods	Design process, concept effective modular design, architectural design, function oriented design, user interface design, Data Design, Architectural Designing, Process And Optimization, Interface Design, Procedural Design, Difference Between Data And Information, ER Diagram, Dataflow Model, Control Flow Model, Control And Process Specification, Data Dictionary.	08
Object Oriented Methodology for Analysis and Design	Introduction to OO Methodology, Object model, Dynamic model, Functional Model for Software Analysis and Design. Requirement's Analysis and Model – Actors and Use cases, Use case Narratives and Scenario, Managing Requirements.	08
Modeling with UML	Basic Structural Modeling, Class Diagram and Relationship, Package Diagram, Object Diagram. Use case diagram: Extends, Uses and Includes Relationship. Interaction Diagram (Sequence Diagram and Coloration Diagram), Components, Pattern and Frame works, State Transition Diagram, Activity Diagram, Deployment and Component	08
Testing Object Oriented System and Quality Assurance	Overview of Testing activities and Techniques, Test case generation and Test suites, Managing Testing. Test case from Use case. OO Metrics, Quality models, Software reliability; software reuse; safety-critical software.	08

Software Architecture	Software Architecture in Practice: Industrial Best Practices; Role of the Architect; Evaluation; Case Studies; Cultural Aspects. Foundations of Software Architecture: Description Languages; Analysis Methods; Transformations; Assessment; Extraction/Recovery. Software connectors: Architecture description languages (ADLs), Dynamism in software architectures, Architecture-based testing and analysis, From architecture to design: overview of UML, Role of UML in software architectures.	08
Software Agent	Agent Oriented Vs. OO Software Development, Design Methods, Multi Agent System, Use of UML, Agent methodologies in Industries, Component based Software Engineering.	08
Practicals/Tutorials		60

Text Books:

1. Pressman R.S., "Software Engineering: A Practitioner's Approach" Tata Mcgraw Hill.
2. Sommerville I., Addison-Wesley, "Software Engineering"

Reference Books.

1. Ian Sommerville, "Software Engineering", Addison Wesley
2. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall of India
3. Jacobson, Jonsson, Overgaard, Christerson, "Object Oriented Software Engineering" Addison Wesley.
4. Martin Fowler, Kendall Scott, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", Addison Wesley, Second Edition, August 18, 1999, ISBN: 0-201-65783-X.
5. Jacobson, Jonsson, Overgaard, Christerson, "Object Oriented Software Engineering", Addison Wesley.

Name of Unit of Qualification
Duration

: CE1.1-R4: DIGITAL SIGNAL PROCESSING

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Discrete Time Signals & System	Discrete-time signals, Discrete-time systems, Analysis of discrete-time LTI systems, Discrete-time systems described by differential equations, Implementation of discrete-time systems, Correlation of discrete-time systems	05
Z-Transform	Definition and Properties of Z-transform, Rational Z-transforms, Inverse Z-transform, one-sided Z-transform, Analysis of LTI systems in Z-domain	04
Application of Z-Transform	Time domain analysis, frequency response - graphical interpretation, application: digital audio effects	02
Frequency Analysis of Signals and Systems	Frequency analysis: Continuous time signals and Discrete-time signals, Properties of the Fourier transform for discrete-time signals, Frequency domain characteristics of LTI systems, LTI system as a frequency selective filter, Inverse systems and deconvolution	05
Discrete Fourier Transform	Frequency domain sampling, Properties of DFT, Linear filtering method based on DFT, Frequency analysis of signals using DFT, FFT algorithm, Applications of FFT, Goertzel algorithm, Quantisation effects in the computation of DFT	08
Implementation of Discrete Time Systems	Frequency domain sampling, Properties of DFT, Linear filtering method based on DFT, Frequency analysis of signals using DFT, FFT algorithm, Applications of FFT, Goertzel algorithm, Quantisation effects in the computation of DFT	08
Design of Digital Filters	Design of FIR filters, Design of IIR filters from analog filters, frequency transformations, Design of digital filters based on least-squares method digital filters from analogue filters, Properties of FIR digital filters, Design of FIR filters using windows, Comparison of IIR and FIR filters, and Linear phase filters.	08
Introduction to DSP co-processors	TMS 320C40/50, Analog Devices	04

Applications	Image processing, Speech, Audio, Telecommunication, Graphics, image enhancement, 3- D rendering, Navigation, GPS , Correlation, machine vision, Frequency domain filtering.	08
Advance DSP concepts	Multirate signal processing, adaptive signal processing, finite word length effect	08
Practicals/Tutorials		60

Text Books:

1. J.G. Proakis, "Introduction to Digital Signal Processing", PHI
2. N.G.Palan, "Digital Signal Processing", Tech-Max Publications
3. S Sallivahanan, "Digital Signal Processing" , Tata McGraw-Hill.
4. Ashok Ambardar, "Analog and Digital Signal Processing" , Thompson Learning

Reference Books.

1. S.K.Mitra, "Digital Signal Processing", Tata McGraw-Hill.
2. Oppenheim and Schaffer, "Discrete Time Signal Processing".
3. E.C.Ifeachor, B.W.Jervis, "Digital Signal Processing", Pearson Education
4. L.C.Ludeman, John Wiley, "Fundamentals of Digital Signal Processing".

**Name of Unit of
Qualification
Duration**

: CE1.2-R4: MACHINE LEARNING

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction	Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation	04
Inductive Classification	The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias.	06
Ensemble Learning	Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles	08
Experimental Evaluation of Learning Algorithms	Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing	08
Rule Learning: Propositional and First-Order	Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Horn-clause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol.	10
Artificial Neural Networks	Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Over fitting, learning network structure, recurrent networks	08
Support Vector Machines	Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions	08

Bayesian Learning	Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies	08
Practicals/Tutorials		60

Text Books:

1. TOM Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 2004.

Reference Books.

1. Christopher M.Bishop, Springer, "Pattern Recognition and Machine Learning", 2006.
2. Richard O.Duda, Peter E.Hart & David G.Stork, "Pattern Classification", Second Edition, Wiley & Sons, 2001.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedma, "The Elements of Statistical Learning", Springer, 2001

Name of Unit of Qualification

: CE1.3-R4: CYBER FORENSIC AND LAW

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction	History of Forensics, Rules of Computer Forensics, Technology Abuses Affecting Corporate and Personal Securities, Defining Cyber Forensics, Cyber Forensics Investigation Process, Dividing Force Behind implementing Corporate Cyber. Overview of cyber crimes	06
Cyber Forensics Tools and Utilities	Introduction, Cyber Forensics Tools, Tool Review, Coroner's Toolkit, EnCase Forensic, i2 Analyst's Notebook, LogLogic's LX2000, Mandiant First Response, NetWitness, ProDiscover Incident Resoinsem Sleuth Kit and Autopsy Browser, Additional Tools for the Investigators, SafeBack, GetTime, FileList, FileCnvt, Getfree, Swap Files, Temporary Files	08
Concealment Techniques	Spoliation, Secret Key Cryptography, Public Key Cryptography, Hash Function, Spoofing, Internet Protocol, Transmission Control Protocol, Hijacked Session Attacks, Polymorphism, Steganography, Reversing the Steganographic process, Counter- or Anti Forensics, Cloaking Techniques: Data hide and seek, Renaming Files, Manipulating File Systems, and Data Hiding on NTFS	06
. Hardware: Model System Platforms	Introduction, Computers, Power Supply, Hard Drive, Laptops, Tablets, External Storage, Servers, I-Pods, PDAs, Digital appliances such as washing machines, microwave ovens	04
Software: Operating Systems, Network Traffic and Applications	Introduction, NIST, Using Data from Operating Systems, BIOS, Volatile Data, Using Data From Network Traffic, Network Forensics Analysis Tools, Collecting Network Traffic Data, Examining Collected data, Identify an Event of Internet, Examine data sources, Data Source Value, Examination and Analysis Tolls, Attackers Identification, e-mail, Web Usage, Interactive Communication, Security Applications	10
Standard Operating Procedures: Digital Forensic	Digital Forensic Laboratory accreditation Standards, Laboratory Manager Checklist, Digital Forensics Examiner Checklist, Technician or Assistant Checklist, Budget Checklist, Training and Testing	10

Laboratory Accreditation Standards	Checklist, Evidence Control Checklist, Quality Assurance Checklist, Equipment Checklist, Health and Safety Checklist, Laboratory Facilities Checklist	
Acquiring Data, Duplicating Data, and Recovering Deleted Files	Recovering Deleted Files and Deleted Partitions: Deleting Files, Recycle Bin, Data Recovery in Linux, Recovering Deleted Files, Deleted File recovery Tools, Recovering Deleted Partitions, Deleted Partition Recovery Tools, Data Acquisition and Duplication	08
Forensic Discovery and Analysis Using Backtrack	Digital Forensics, Acquiring Images, Forensic Analysis, File Carving	05
Privacy and Cyber Forensics	Law Relating and Privacy, Common Law Privacy, Privacy: Common Law Privacy, Constitutional Law; Legal Liability for Mistakes	03
Practicals/Tutorials		60

Text Books:

1. Albert J. Marcella, Jr. Doug Menendez, "Cyber Forensics", Second Edition, Auerbach Publications.
2. Anthony Reyes & Jack Wiles, "Cybercrime and Digital Forensics", Syngress.

Reference Books.

1. Dan Farmer & Wietse Venema, "Forensics Discovery", Addison-Wesley, Professional Computing Series
2. Jonathan Rosenoer, "Cyber Law: The law of the internet", Springer Verlag, 1996

Name of Unit of Qualification

: CE1.4-R4: PROJECT MANAGEMENT

Duration

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introduction to Software Project Management System	Software Development as a project, stakeholders in software project, software product, processes, quality and cost, objectives, issues and problems relating to software projects.	06
Overview of Project Planning	Steps in project planning, defining scope and objectives, deliverables and other products, alternatives in planning,	08
Project Estimation	Project Size Estimation Metric: LOC, FP, Feature Point. Estimation Technique: Empirical, Heuristics and analytical. COCOMO Model, Halstead, Putnam and SLIM models for Time and Effort Estimation. Staffing Level Estimation: Effect on schedule change on cost and Jensen model.	06
Project Scheduling	Work Breakdown structure, Activity Network: Network planning model, Activity –on-arrow network, precedence network, Forward and Backward pass, Critical Path, Slack and float, Gantt Chart, PERT Charts.	06
Organization and Team Structure	Overview of Organization structure and Team Structure, Organizational Behavior, Recruitment and Placement, Staffing, Motivation and Group Behavior. Individual and Group Decision making, Leadership and Leader style, Forms of Organizational Structure	06
Risk Analysis and Management	Risk Identification, Nature and Categories of Risk in software Development, Risk Assessment; Risk Mitigation, Monitoring and Management(RMM), RMM Plan, Risk Containment, Evaluating Scheduling Risk using PERT.	04
Resource Allocation	Nature of Project Resources, Identifying resource requirement for Activities, Allocating and Scheduling Resources, Cost of Resources, Standard, Plan and Actual Cost, Cost variance, Time cost trade off.	06
Project Tracking and Configuration Management	Measurement of Physical and Financial progress, Earned value analysis, Status reports and Milestone reports. Necessity of configuration management, Configuration Management Activity, Change control, Source code Control System (SCCS).	06

Project Contract Management	Outsourcing of products and services, Types of contract, Stages in contract placement, Terms and Condition of contract, Contract monitoring and Acceptance Testing.	06
Software Quality Assurance	Quality Control, Assurance, Movements, SQA-Software Quality Assurance Activities, Approaches To SQA, Reliability, ISO 9000 And 9001, CMM Levels, Quality Audit. (CMMI Levels may be included as CMM is replaced with CMMI)	06
Practicals/Tutorials		60

Text Books:

1. Bob Hughes and Mike Cotterell, "Software Project Management", 3rd Edition, 2002, Mc Graw-Hill.
2. Pankaj Jalote, "Software Project management in Practice", 2002, POearson Education, Asia.

Reference Books.

1. Roger S. Pressman, "Software Engineering: A Practical Approach", 5th Edition, 2001, McGraw-Hill.
2. Ian Sommerville, "Software Engineering", Addison Wesley.
3. Rajib Mall, "Fundamentals of Software Engineering", Prectice Hall of India.

**Name of Unit of
Qualification
Duration**

: CE1.5-R4: MOBILE COMPUTING

: 120 Hours

Performance Criteria(OUTCOME) No.	Contents	Hrs.
Introductory Framework	Concept of mobile computing, basic architecture. mobile devices, limitations of mobile devices.	03
Wide Area Mobile Communication Access	GSM architecture and operations - radio interfaces, handover, security; General Packet Radio Service (GPRS); CDMA Systems - WCDMA, IMT-2000, UMTS,	07
Local Area Mobile Communication Access	Basic MAC protocol CSMA/CA, Infrastructure and ad hoc network topologies, MACA, MACAW; use of PCF, IEEE 802.11 standards, Hiperlan; IrDA; Blue Tooth, ZigBee.	07
Mobile Network Layer	Routing algorithms - DSR, AODV, TORA, CGSR. Mobile IP- basic concept, handover management, location management, registration, tunneling, route optimization, dynamic host configuration..	08
Mobile Transport Layer	Limitations of TCP in mobile wireless systems, TCP fixes – Snooping, Indirect TCP; TCP variants - Fast retransmit/recovery, TCP - Reno, TCP-freeze, TCP-Transaction oriented, Explicit notification	06
Mobile Databases	Basic concepts - Hoarding and caching, cache - invalidation, client - server computing architecture, transaction models, query processing, data recovery. Data dissemination - communication asymmetry, data delivery mechanisms, broadcast disks, selective tuning and indexing; synchronization protocols.	09
Mobile Server and Management	Mobile agents, gateways, service discovery, device management, mobile file system	06
Mobile Operating Systems	Basic concepts; requirements, Symbian OS, Palm OS.	04
Te Programming and Language Support	WAP architectures, WML, X HTML - MP, XML, J2ME.	05
Security in Mobile Computing	Information security, techniques and algorithms, protocols, trust, security models and frame works.	05

Practicals/Tutorials		60
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Text Books:

1. Raj Kamal, "Mobile Computing", Oxford University Press.
2. A.K. Talukder and R.R. Yavagal, "Mobile Computing : Applications and Service Technology, Creation", Tata-McGraw Hill.

Reference Books.

1. W. Stallings, "Wireless Communications and Networks", Pearson Education.
2. P. Nicopolitidis, M.S. Obaidat, G. Papadimitriou and A.S. Pomportsis, "Wireless Networks", Wiley (Singapore Edition).