

ANNEXURE - I

Scheme of Study for Bachelor of Science in
Computer Science
BS (CS)

**Scheme of Study for Bachelor of Science in
Computer Science BS (CS)
4-year programme (8 semesters)**

#	Category	# of Courses	Credit Hours
1	Computing Courses	21	70
	Core Courses (Comp-Core)	12	43
	Supporting Areas (Comp-Supp)	4	12
	General Education (Comp-Gen)	5	15
2	Computer Science Courses	16	48
	CS Core Courses (CS-Core)	6	18
	CS Elective Courses (CS-Elec)	7	21
	CS Supporting Courses (CS-Supp)	3	9
3	University Electives (Univ-Elec)	6	18
	Total	43	136

Semester-I: (20 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 101	Comp-Core	Introduction to Computing	4 (3,1)	
2	CS 103	Comp-Core	Programming Fundamentals	4 (3,1)	
3	MT 105	Comp-Supp	Calculus and Analytical Geometry	3 (3,0)	
4	EG 107	Comp-Gen	Functional English (English-I)	3 (3,0)	
5	PK 109	Comp-Gen	Islamic and Pakistan Studies	3 (3,0)	
6	SS 111	Univ-Elec	Philosophy	3 (3,0)	

Semester-II: (19 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 102	Comp-Core	Discrete Structures	3 (3,0)	
2	CS 104	Comp-Core	Object Oriented Programming	4 (3,1)	Programming Fundamentals
3	ST 106	CS-Supp	Multivariable Calculus	3 (3,0)	Calculus & Analytical Geometry
4	MT 108	Comp-Supp	Probability and Statistics	3 (3,0)	
5	EG 110	Comp-Gen	Communication Skills (English-II)	3 (3,0)	
6	SS 112	Univ-Elec	Economics	3 (3,0)	

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Semester-III: (19 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 201	Comp-Core	Digital Logic Design	3 (3,0)	
2	CS 203	Comp-Core	Data Structures and Algorithms	4 (3,1)	Discrete Structures
3	MT 205	Comp-Supp	Linear Algebra	3 (3,0)	
4	EL 207	Comp-Supp	Basic Electronics	3 (2,1)	
5	EG 209	Comp-Gen	Technical & Report Writing (English-III)	3 (3,0)	
6	MG 211	Univ-Elec	Financial Accounting	3 (3,0)	

Semester-IV: (18 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 202	Comp-Core	Operating Systems	3 (3,0)	
2	CS 204	Comp-Core	Intro. to Database Systems	3 (2,1)	Data Structures and Algorithms
3	CS 206	Comp-Core	Intro. to Software Engineering	3 (3,0)	Programming Fundamentals/OOP
4	CS 208	CS-Core	Computer Organization & Assembly Languages	3 (2,1)	Digital Logic Design
5	ST 210	CS-Supp	Differential Equations	3 (3,0)	Calculus & Analytical Geometry
6	MG 212	Univ-Elec	Marketing	3 (3,0)	

Semester-V: (18 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 301	Comp-Core	Computer Communications and Networks	3 (3,0)	Operating Systems
2	CS 303	Comp-Core	Human Computer Interaction	3 (2,1)	Data Structures & Algorithms
3	CS 305	CS-Core	Theory of Automata and Formal Languages	3 (3,0)	Discrete Structures
4	CS 307	CS-Core	Computer Architecture	3 (3,0)	Digital Logic Design
5	CS 309	CS-Elec	Web Engineering	3 (2,1)	
6	MG 311	Univ-Elec	Financial Management	3 (3,0)	

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Semester-VI: (18 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 302	CS-Core	Compiler Construction	3 (2,1)	Theory of Automata & Formal Languages
2	CS 304	CS-Core	Design and Analysis of Algorithms	3 (3,0)	Data Structures & Algorithms
3	CS 306	CS-Supp	Numerical Computing	3 (2,1)	Calculus & Analytical Geometry
4	CS 308	CS-Elec	Computer Graphics	3 (2,1)	Data Structures & Algorithms
5	CS 310	CS-Elec	Distributed Computing	3 (2,1)	Computer Comm. & Networks
6	MG 312	Univ-Elec	Human Resource Management	3 (3,0)	

Semester-VII: (15 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 401	CS-Core	Artificial Intelligence	3 (2,1)	Discrete Structures
2	CS 403	CS-Elec	Software Engineering II	3 (3,0)	
3	CS 405	CS-Elec	Distributed Database Systems	3 (2,1)	Database Systems
4	CS 407	CS-Elec	Network Security	3 (3,0)	Computer Comm. & Networks
5	CS 409	CS-Elec	Visual Programming	3 (2,1)	OOP, Data Structures

Semester-VIII: (9 Credit Hours)

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS 402	Comp-Gen	Professional Practices	3 (3,0)	
2	CS 404	Comp-Core	Final Year Project	6 (0,6)	SE, Database System Computer Archi.

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Electives for BS (CS)

CS Elective Courses:

#	Course Code	Category	Course Title	Credit Hours	Prerequisites
1	CS	CS-Elec	Software Engineering II	3 (3,0)	
2	CS	CS-Elec	Data Communications	3 (3,0)	
3	CS	CS-Elec	Principles of Programming Languages	3 (3,0)	
4	CS	CS-Elec	Computer Graphics	3 (2,1)	Data Struc. & Algo.
5	CS	CS-Elec	Digital Image Processing	3 (2,1)	Data Struc. & Algo.
6	CS	CS-Elec	Visual Programming	3 (2,1)	
7	CS	CS-Elec	Distributed Computing	3 (2,1)	
8	CS	CS-Elec	Network Security	3 (3,0)	Computer Comm. and Networks
9	CS	CS-Elec	Computer Vision	3 (3,0)	Data Struc. & Algo.
10	CS	CS-Elec	Systems Programming	3 (2,1)	Operating Systems
11	CS	CS-Elec	Distributed Database Systems	3 (2,1)	Database Systems
12	CS	CS-Elec	Data Warehousing	3 (3,0)	Database Systems
13	CS	CS-Elec	Web Engineering	3 (2,1)	
14	CS	CS-Elec	Artificial Neural Networks	3 (2,1)	Artificial Intelligence
15	CS	CS-Elec	Expert Systems	3 (2,1)	
16	CS	CS-Elec	Operations Research	3 (3,0)	
17	CS	CS-Elec	Network Programming	3 (2,1)	Computer Comm. and Networks
18	CS	CS-Elec	Wireless Networks	3 (3,0)	
19	CS	CS-Elec	Telecommunication Systems	3 (2,1)	
20	CS	CS-Elec	Mobile Computing	3 (2,1)	

University Electives Courses:

#	Course Code	Category	Course Title	Credit Hours
1	MG	Univ-Elec	Financial Accounting	3 (3,0)
2	MG	Univ-Elec	Financial Management	3 (3,0)
3	MG	Univ-Elec	Human Resource Management	3 (3,0)
4	EG	Univ-Elec	Business Communications and Technical Writing	3 (3,0)
5	MG	Univ-Elec	Marketing	3 (3,0)
6	SS	Univ-Elec	Economics	3 (3,0)
7	SS	Univ-Elec	Philosophy	3 (3,0)
8	SS	Univ-Elec	Psychology	3 (3,0)
9	SS	Univ-Elec	International Relations	3 (3,0)
10	SS	Univ-Elec	Foreign/Regional Languages (French, German, Chinese, Japanese, Russian, Sindhi, Punjabi, Balochi, Pashto etc.)	3 (3,0)

Detailed Courses Outline for BS (CS)

Description of Computing-Core and CS-Core Courses

Course Name: Introduction to Computing

Course Structure: Lectures: 3, Labs: 1 **Credit Hours:** 4

Objectives: This course focuses on a breadth-first coverage of computer science discipline, introducing computing environments, general application software, basic computing hardware, operating systems, desktop publishing, Internet, software applications and tools and computer usage concepts; Introducing Software engineering and Information technology within the broader domain of computing, Social issues of computing.

Course Outline: Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition, design, and implementation, Programming paradigms and languages, Graphical programming, Overview of Software Engineering and Information Technology, Operating system, Compiler, Computer networks and internet, Computer graphics, AI, Social and legal issues.

Reference Material:

1. “Computers: Information Technology in Perspective, 9/e”, Larry Long and Nancy Long, Prentice Hall, 2002 / ISBN: 0130929891
2. “An Invitation to Computer Science”, Schneider and Gersting, Brooks/Cole Thomson Learning, 2000
3. “An overview of Computer Science”, Sherer

Course Name: Programming Fundamentals

Course Structure: Lectures: 3, Labs: 1 **Credit Hours:** 4

Objectives: The course is designed to familiarize students with the basic structured programming skills. It emphasizes upon problem analysis, algorithm designing, and program development and testing.

Course Outline: Overview of computers and programming. Overview of language for e.g. C language C. Basics of structured and Modular programming. Basic Algorithms and problem solving, development of basic algorithms, analyzing problem, designing solution, testing designed solution. Fundamental programming constructs, translation of algorithms to programs, data types, control structures, functions, arrays, records, files, testing programs.

Reference Material:

1. “Problem Solving and Program Design in C / 6th Ed.”, Hanly & Koffman Addison-Wesley Publisher 2009. ISBN-10: 0321535421 | ISBN-13: 9780321535429
2. “C How to Program 5th Ed”, (Harvey & Paul) Deitel & Deitel, ISBN-10: 0132404168 ISBN-13: 9780132404167 Publisher: Prentice-Hall 2007

Course Name: Object Oriented Programming

Course Structure: Lectures: 3, Labs: 1 **Credit Hours:** 4

Prerequisites: Programming Fundamentals

Objectives: The course aims to focus on object-oriented concepts, analysis and software

development.

Course Outline: Evolution of Object Oriented (OO) programming, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes, methods, objects and encapsulation; constructors and destructors, operator and function overloading, virtual functions, derived classes, inheritance and polymorphism. I/O and file processing, exception handling

Reference Material:

1. "C++ How to Program, 6th Ed.", (Harvey & Paul) Deitel & Deitel ISBN-10: 0136152503 ISBN-13: 9780136152507 Publisher: Prentice Hall
2. "Java How to Program, 7th Ed.", (Harvey & Paul) Deitel & Deitel : Prentice Hall.

Course Name: Discrete Structures

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours: 3**

Objectives: Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

Course Outline: Introduction to logic and proofs: Direct proofs; proof by contradiction, Sets, Combinatorics, Sequences, Formal logic, Propositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeonhole principle, Trees and Graphs, Elementary number theory, Optimization and matching. Fundamental structures: Functions; relations (more specifically recursions); pigeonhole principle; cardinality and countability, probabilistic methods.

Reference Material:

1. "Discrete Mathematics and Its Applications, 6TH edition", Kenneth H. Rosen, McGraw Hill Book Co. 2006
2. "Discrete Mathematics, 7TH edition", Richard Johnsonbaugh, Prentice-Hall, 2008.
3. "Discrete Mathematical Structures, 4th edition", Kolman, Busby & Ross, Prentice-Hall Publishers 2000.
4. "Discrete and Combinatorial Mathematics: An Applied Introduction", Ralph P. Grimaldi, Addison-Wesley Pub. Co., 1985.

Course Name: Operating Systems

Course Structure: Lectures: 3, Labs: 0 **Credit Hours: 3**

Prerequisites: None

Objectives: To help students gain a general understanding of the principles and concepts governing the functions of operating systems and acquaint students with the layered approach that makes design, implementation and operation of the complex OS possible.

Course Outline: History and Goals, Evolution of multi-user systems, Process and CPU management, Multithreading, Kernel and User Modes, Protection, Problems of cooperative processes, Synchronization, Deadlocks, Memory management and virtual memory, Relocation, External Fragmentation, Paging and Demand Paging, Secondary storage, Security and Protection, File systems, I/O systems, Introduction to distributed operating systems. Scheduling and dispatch, Introduction to concurrency.

Lab assignments involving different single and multithreaded OS algorithms.

Reference Material:

1. "Applied Operating Systems Concepts, 7th Edition", Silberschatz A., Peterson, J.L., & Galvin P.C. 2004.
2. "Modern Operating Systems, 3rd Edition", Tanenmaum A.S., 2008.

Course Name: Introduction to Database Systems

Course Structure: Lectures: 2, Labs: 1 **Credit Hours: 3**

Prerequisites: Data Structures and Algorithms

Objectives: The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.

Course Outline: Basic database concepts; Entity Relationship modeling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database security and authorization. Small Group Project implementing a database. Physical database design: Storage and file structure; indexed files; b-trees; files with dense index; files with variable length records; database efficiency and tuning.

Reference Material:

1. "Database Systems", C.J.Date, Addison Wesley Pub. Co. 2004.
2. "Database Systems: A Practical Approach to Design, Implementation and Management", R.Connolly and P.Begg, Addison-Wesley Pub. Co. 2009.
3. "Fundamentals of Database Systems", Elmasri and Navathe, Addison-Wesley, ISBN: 0-201-74153-9.

Course Name: Introduction to Software Engineering

Course Structure: Lectures: 3, Labs: 0 **Credit Hours: 3**

Prerequisites: Programming Fundamentals/Object Oriented Paradigm

Objectives: To study various software development models and phases of software development life cycle. The concepts of project management, change control, process management, software development and testing are introduced through hands-on Team Projects.

Course Outline: Introduction to Computer-based System Engineering; Project Management; Software Specification; Requirements Engineering, System Modelling; Requirements Specifications; Software Prototyping; Software Design: Architectural Design, Object-Oriented Design, UML modelling, Function-Oriented Design, User Interface Design; Quality Assurance; Processes & Configuration Management;

Introduction to advanced issues: Reusability, Patterns; Assignments and projects on various stages and deliverables of SDLC.

Reference Material:

1. “Software Engineering”, Sommerville, Addison-Wesley, 2006
2. “Software Engineering: A Practitioner's Approach”, Roger Pressman, McGraw-Hill, 2009

Course Name: Computer Communication and Networks

Course Structure: Lectures: 3, Labs: 0 **Credit Hours: 3**

Objectives: To introduce students to the concept of computer communication. Analogue & digital transmission. Network Layers, Network models (OSI, TCP/IP) and Protocol Standards. Emphasis is given on the understanding of modern network concepts.

Course Outline: Analogue and digital Transmission, Noise, Media, Encoding, Asynchronous and Synchronous transmission, Protocol design issues. Network system architectures (OSI, TCP/IP), Error Control, Flow Control, Data Link Protocols (HDLC, PPP). Local Area Networks and MAC Layer protocols (Ethernet, Token ring), Multiplexing, Switched and IP Networks, Inter-networking, Routing, Bridging, Transport layer protocols TCP/IP, UDP. Network security issues. Programming exercises, labs or projects involving implementation of protocols at different layers.

Reference Material:

1. “Introduction to Computer Networks”, A. S. Tanenbaum, Prentice Hall 2003
2. “Computer Networks and Internets”, Douglas E. Comer, Purdue University ISBN-10: 0136061273 ISBN-13: 9780136061274 Publisher: Prentice Hall 2008
3. “Data and Computer Communications”, William Stallings, Published Macmillan Pub. Co., 8th Edition 2006

Course Name: Human Computer Interaction

Course Structure: Lectures: 2, Labs:1 **Credit Hours: 3**

Prerequisites: Data Structures and Algorithms

Objectives: This course introduces the human issues of usability and its importance. It considers the implications of human understanding on the usability of computer systems and the importance of understanding the context of use. It describes guidelines for use of different media and interface styles. Topics include Usability Design principals, standards and models, evaluation techniques. Groupware, pervasive and ubiquitous applications.

Course Outlines: The Human, Computer and Interaction, Usability paradigm and principles, Introduction to design basics, HCI in software process, Design rules, prototyping, evaluation techniques, task analysis, Universal design and User support and Computer Supported Cooperative Work. Introduction to specialized topics such as Groupware, pervasive and ubiquitous applications.

Reference Material:

1. “Human-Computer Interaction, 3/E”, *Alan Dix*, Computing Dept, Lancaster University, *Janet E. Finlay*, Leeds Metropolitan University, *Gregory D. Abowd*, Georgia Institute of Technology, *Russell Beale*, University of Birmingham ISBN-10:

0130461091 ISBN-13: 9780130461094 Publisher: Prentice Hall

2. “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, 4/E *Ben Shneiderman*, University of Maryland *Catherine Plaisant*, University of Maryland ISBN-10: 0321197860 ISBN-13: 9780321197863 Publisher: Addison-Wesley

Course Name: Computer Organization and Assembly Language

Course Structure: Lectures: 2, Labs: 1 **Credit Hours: 3**

Prerequisites: Digital Logic Design

Objectives: The main objective of this course is to introduce the organization of computer systems and usage of assembly language for optimization and control. Emphasis should be given to expose the low-level logic employed for problem solving while using assembly language as a tool. At the end of the course the students should be capable of writing moderately complex assembly language subroutines and interfacing them to any high level language.

Course Outline: Microprocessor Bus Structure: Addressing, Data and Control, Memory Organization and Structure (Segmented and Linear Models), Introduction to Registers and Flags, Data Movement, Arithmetic and Logic, Program Control, Subroutines, Stack and its operation, Peripheral Control Interrupts, Interfacing with high level languages, Real-time application.

Objectives and Perspectives of Assembly Language, Addressing Modes, Introduction to the Assembler and Debugger, Manipulate and translate machine and assembly code, Describe actions inside the processing chip, Discuss operations performed by an instruction set, Write a fully documented program, Using an assembler of choice.

Reference Material:

1. "Computer Organization & Architecture", 7th ed, Stallings, Prentice Hall, 2006.
2. “Assembly Language for Intel-based Computers”, 5th ed, Irvine, Prentice Hall, 2007.
3. “Computer Organization and Design, The Hardware/Software Interface”, 4th ed, David A. Patterson and John L. Hennessy, 2008. Elsevier Publishers.

Course Name: Theory of Automata and Formal languages

Course Structure: Lectures: 3 Labs: 0 **Credit Hours: 3**

Prerequisites: Discrete Structures

Objectives: The course aims to develop an appreciation of the theoretical foundations of computer science through study of mathematical & abstract models of computers and the theory of formal languages. *Theory of formal languages* and use of various abstract machines as ‘recognizers’ and parsing will be studied for identifying/validating the synthetic characteristics of programming languages. Some of the abstract machines shall also study as ‘Transducers’.

Course Outline: *Finite State Models:* Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene’s theorem, Transducers (automata with output), Pumping lemma and non regular language *Grammars and PDA:* Context free grammars, Derivations, derivation trees and ambiguity, Simplifying CFLs , Normal form grammars and parsing, Decidability,

Chomsky's hierarchy of grammars *Turing Machines Theory*: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Context sensitive Grammars, Defining Computers by TMs.

Text Book/Reference Books:

1. "An Introduction to Formal Languages and Automata", 4th ed., Peter Linz, Jones & Bartlett Publishers, 2006
2. "Theory of Automata, Formal Languages and Computation", S. P. Eugene, Kavier, 2005, New Age Publishers, ISBN (10): 81-224-2334-5, ISBN (13) : 978-81-224-2334-1.
3. "Introduction to Automata Theory, Languages, and Computation", 2nd ed., John Hopcroft and Jeffrey Ullman, 2001, Addison-Wesley.
4. "Introduction to Languages and the Theory of Computation", 3rd ed., John C. Martin 2002, McGraw-Hill Professional.

Course Name: Design and Analysis of Algorithms

Course Structure: Lectures: 3 / Labs: 0 **Credit Hours: 3**

Prerequisites: Discrete Structure, Data Structures and Algorithms

Objectives: Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.

Course Outline: Introduction; Asymptotic notations; Recursion and recurrence relations; Divide-and-conquer approach; Sorting; Search trees; Heaps; Hashing; Greedy approach; Dynamic programming; Graph algorithms; Shortest paths; Network flow; Disjoint Sets; Polynomial and matrix calculations; String matching; NP complete problems; Approximation algorithms.

Reference Material:

1. "Introduction to Algorithms", T. H. Cormen, C. E. Leiserson, and R. L. Rivest, MIT Press, McGraw-Hill, New York, NY, 2001.
2. "Algorithms in C++", Robert Sedgewick

Course Name: Artificial Intelligence

Course Structure: Lectures: 2 Labs: 1 **Credit Hours: 3**

Prerequisites: Discrete Structures

Objectives: This course studies four main objectives of AI. Modeling the environment by constructing computer representations of the real world. Perception and reasoning - obtaining and creating information/*knowledge* to populate a computational representation. Taking actions by using the knowledge of the environment and desired goals to plan and execute actions. Learning from past experience.

Course Outline: Artificial Intelligence: Introduction, Intelligent Agents. Problem-solving: Solving Problems by Searching, Informed Search and Exploration, Constraint Satisfaction Problems, Adversarial Search. Knowledge and reasoning: Logical Agents, First-Order Logic, Inference in First-Order Logic, Knowledge Representation. Planning and Acting in the Real World. Uncertain knowledge and reasoning: Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions. Learning:

Learning from Observations, Knowledge in Learning, Statistical Learning Methods, Reinforcement Learning. Communicating, perceiving, and acting: Communication, Probabilistic Language Processing, Perception and Robotics. Introduction to LISP/PROLOG and Expert Systems (ES) and Applications.

Reference Material:

1. “Artificial Intelligence: Structures and Strategies for Complex Problem Solving: International Edition”, George F. Luger, 6th edition: Pearson Education, 2008.
2. “Artificial Intelligence: A Modern Approach”, Stuart Jonathan Russell, Peter Norvig, John F. Canny, 2nd Edition, Prentice Hall, 2003.

Course Name: Computer Architecture

Course Structure: Lectures: 3, Labs: 0

Credit Hours: 3

Prerequisites: Digital Logic and Design

Objectives: Get a deeper understanding of how computers work, working knowledge of various subsystems and the general principles that affect their performance, analyze the performance of systems and quantify the performance measurements, fundamentals of all technologies, and advanced architectural features that boost the performance of computers.

Course Outlines: Fundamentals of Computer Design including performance measurements & quantitative principles, principles of Instruction Set Design, Operands, addressing modes and encoding, pipelining of Processors: Issues and Hurdles, exception handling features, Instruction-Level Parallelism and Dynamic handling of Exceptions, Memory Hierarchy Design, Cache Design, Performance Issues and improvements, Main Memory Performance Issues, Storage Systems, Multiprocessors and Thread Level Parallelism. Case Studies.

Resources:

1. “Computer Architecture: A Quantitative Approach”, Hennessy & Patterson, Morgan & Kauffman Series (2006) Fourth Edition.
2. “Computer Organization & Design : The Hardware/Software Interface”, Patterson & Hennessy, Morgan & Kauffman Series 2008.

Course Name: Compiler Construction

Course Structure: Lectures: 2, Labs: 1

Credit Hours: 3

Prerequisites: Theory of Automata and Formal Languages

Objectives: At the end of the course students should understand the overall structure of a compiler, and will know significant details of a number of important techniques commonly used. They will be aware of the way in which language features raise challenges for compiler builders.

Course Outline: Compiler techniques and methodology. Organization of compilers. Lexical and syntax analysis. Parsing techniques. Object code generation and optimization, detection and recovery from errors. Contrast between compilers and interpreters.

Reference Material:

1. “Compilers: Principles, Techniques, and Tools”, Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Contributor Jeffrey D. Ullman, Addison-Wesley Pub. Co., 2nd edition, 1987

Original from the University of Michigan

2. “Modern Compiler Implementation in C”, Andrew W. Appel, Maia Ginsburg, Contributor Maia Ginsburg, Cambridge University Press, 2004.
3. “Modern Compiler Design”, Dick Grune, Henri E. Bal, Criel J. H. Jacobs, Koen G. Langendoen, 2003, John Wiley & Sons.

Course Name: Software Project

Course Structure: Lectures: 0, Labs: 6 **Credit Hours: 6**

Prerequisites: Introduction to Software Development, Database Systems, Computer Architecture

Objectives: The software project involves research, conceive, plan and develop a real and substantial project related to computer science. It provides an opportunity to the students to crystallize their acquired professional competence in the form of a demonstrable software product. Make oral and written project presentations.

Resources:

1. “Software Project Management in Practice”, Jalote, Pankaj.

Description of CS-Elective Courses

Course Name: Computer Graphics

Course Structure: Lectures: 2 Labs: 1 **Credit Hours: 3**

Prerequisites: Data Structures & Algorithms, OO Programming/Visual Programming

Objectives: Study of various algorithms in computer graphics and their implementation in any programming language.

Course Outline: Graphics hardware. Fundamental algorithms. Applications of graphics. Interactive graphics programming — graph plotting, windows and clipping, and segmentation. Programming raster display systems, Differential Line Algorithm, panning and zooming. Raster algorithms and software — Scan-Converting lines, characters and circles. Scaling, Rotation, Translation, Region filling and clipping. Two and three dimensional imaging geometry (Perspective projection and Orthogonal projection) and transformations. Curve and surface design, rendering, shading, color and animation.

Reference Material:

1. “Computer Graphics, Principles and Practice,” J. D. Foley, A. van Dam, S. K. Feiner and J. F. Hughes, Addison-Wesley ISBN: 0-201-12110-7.
2. “Computer Graphics”, F.S.Hill, Maxwell MacMillan ISBN: 0-02-354860-6.
3. “Interactive Computer Graphics: Functional, Procedural and Device-level methods”, Peter Burger and Duncan. F. Gillies; Addison-Wesley, (2003)

Course Name: Digital Image Processing

Course Structure: Lectures:3 Labs: 0 **Credit Hours: 3**

Objective: The aim of this module is to understand the main terms & concepts of Information Systems & their applications in everyday business. The main objectives of this module are to make business students aware of the increasing importance of IT, computers and telecom and to manage IT systems in modern organisational structure. Another important objective of this module is to learn about various information systems used in industries and select the appropriate information system for the required application. Restoration in the Presence of Noise Only–Spatial Filtering, Mean Filters, Order-Statistics Filters, Adaptive Filters, Periodic Noise Reduction by Frequency Domain Filtering, Bandreject Filters, Bandpass Filters, Notch Filters. Estimating the Degradation Function, Estimation by Image Observation, Estimation by Experimentation, Estimation by Modeling, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. Image Segmentation, Detection of Discontinuities, Point Detection, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Local Processing, Global Processing via the Hough Transform. Thresholding, The Role of Illumination, Basic Global Thresholding, Basic Adaptive Thresholding, Local Thresholding, Thresholds Based on Several Variables. Region-Based Segmentation, Region Growing, Region Splitting and Merging

Course Name: Computer Vision

Course Structure: Lectures: 3 Labs: 0 **Credit Hours: 3**

Pre-Req: Data Structures and Algorithms

Objectives: By the end of this course Students will be able to explain the concepts behind computer based recognition and the extraction of features from raster images. Students will also be able to illustrate some successful applications of vision systems and will be able to identify the vision systems limitations.

Course Outlines: Concepts behind computer-based recognition and extraction of features from raster images. Applications of vision systems and their limitations. Overview of early, intermediate and high level vision, Segmentation: region splitting and merging; quadtree structures for segmentation; mean and variance pyramids; computing the first and second derivatives of images using the isotropic, Sobel and Laplacian operators; grouping edge points into straight lines by means of the Hough transform; limitations of the Hough transform; parameterisation of conic sections. Perceptual grouping: failure of the Hough transform; perceptual criteria; improved Hough transform with perceptual features; grouping line segments into curves. Overview of mammalian vision: experimental results of Hubel and Weisel; analogy to edge point detection and Hough transform; Relaxation labeling of images: detection of image features; Grouping of contours and straight lines into higher order features such as vertices and facets. Depth measurement in images.

Text Book/Reference Books:

1. "Computer Vision: A Modern Approach", David Forsyth, Jean Ponce, Prentice Hall, 2003.
2. "Computer Vision", Linda G. Shapiro, George C. Stockman, Prentice Hall, 2001.
3. "Handbook of Mathematical Models in Computer Vision", Nikos Paragios, Yunmei Chen, Olivier Faugeras, Birkhäuser, 2006.

Course Name: Software Engineering

Course Structure: Lectures: 3 / Lab: 0 **Credit Hours:** 3

Objective: The students will study techniques for software verification, validation and testing. They would also study reliability and performance issues in software design and development. Upon successful completion of this course the student will be to understand the importance of software engineering to computer science and the most important general approaches to structuring the software production process, analyze the requirements for a software system and produce a software design from requirements (Data Flow Diagram (DFD)), assess software productivity using metrics, use different testing techniques used in software engineering to test software systems, manage the important issues for planning a project.

Course Outlines:

Introduction to Software Engineering, Software Process Framework, Process Models, Agile Software Process, Software Engineering Practices, System Engineering, Requirements Engineering, Analysis Modelling, Design Engineering, Architectural Design, Component Design, User Interface Design, Testing Strategies, Testing Tactics, Product and Process, Metrics, Project Management, Project Estimation, Project Scheduling, Risk Management, Quality Management, Change Management

Text Book/Reference Books:

1. "Software Engineering: A Practitioner's Approach", Roger Pressman, McGraw-Hill,

Sixth Edition, 2005.

2. “Software Engineering”, Ian Sommerville. Addison-Wesley, 2001 (7th edition).
3. “UML Distilled”.

Course Name: Data Communications

Course Structure: Lectures: 3 **Credit Hours:** 3

Objectives: To provide knowledge of Data Communication and different mechanisms of communication

Course Outlines: Introduction, Data and Network, Layers, OSI Model, Introduction to Signals, Transmission Media, Digital Transmission, PAM, PCM, ASK, FSK, PSK, QAM, Data Communication Techniques and technologies, Modulation, Multiplexing, Types of errors, Data Communication Protocols, Current technologies being used for data communication.

Reference Material:

1. “Data Communication and Networking”, 3rd Edition, Behrouz A. Forouzan.
2. “Business Data Communication”, William Stallings.

Course Name: Distributed Computing

Course Structure: Lectures: 2 Labs: 1 **Credit Hours:** 3

Course Outlines: Why use parallel and distributed systems? Why not use them? Speedup and Amdahl's Law, Hardware architectures: multiprocessors (shared memory), networks of workstations (distributed memory), clusters (latest variation). Software architectures: threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD). Parallel Algorithms, Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc. Shared-Memory Programming: Threads, Pthreads, Locks and semaphores, Distributed-Memory Programming: Message Passing, MPI, PVM. Other Parallel Programming Systems, Distributed shared memory, Aurora: Scoped behaviour and abstract data types, Enterprise: Process templates. Research Topics.

Text Books/Reference Books:

1. “Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 1/e”, B. Wilkinson and M. Allen. Prentice Hall, 1999.
2. “Advanced Programming in the Unix Environment”, W. Stevens, Addison Wesley, 1993.

Course Name: Network Security

Course Structure: Lectures: 3 Labs: 0 **Credit Hours:** 3

Course Outlines: Introduction; Cryptology and simple cryptosystems; Conventional encryption techniques; Stream and block ciphers; DES; More on Block Ciphers; The Advanced Encryption Standard. Confidentiality & Message authentication: Hash functions; Number theory and algorithm complexity; Public key Encryption. RSA and Discrete Logarithms; Elliptic curves; Digital signatures. Key management schemes; Identification schemes; Dial-up security. E-mail security, PGP, S-MIME; Kerberos and directory

authentication. Emerging Internet security standards; SET; SSL and IPsec; VPNs; Firewalls; Viruses; Miscellaneous topics.

Text Books/Reference Books:

1. "Cryptography and Network Security", W. Stallings, Prentice Hall PTR, Upper Saddle River, NJ, 2003.
2. "Network Security: Private Communication in a Public World", Kaufman, R. Perlman, M. Speciner, Prentice Hall PTR, Upper Saddle River, NJ, 2002.
3. "Computer Security: Art and Science", M. Bishop, Addison-Wesley, 2003.
4. "Cryptography: Theory and Practice", Stinson, CRC Press, Boca Raton, FL, 1995.
5. "An Introduction to Cryptography", Richard A. Mollin, Chapman and Hall/CRC, 2001.
6. "Applied Cryptography", B. Schneier, John Wiley and Sons, NY, 1996.
7. "Handbook of Applied Cryptography", A. Menezes, P. Oorschot, and S. Vanstone, CRC Press, Boca Raton, FL, 1997.

Course Name: Wireless Networks

Course Structure: Lectures: 3 Labs: 0 **Credit Hours:** 3

Course Outlines: This course covers fundamental techniques in design and operation of first, second, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocols (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, cdma2000, etc), radio resource and network management. As an example for the third generation air interfaces, WCDMA is discussed in detail since it is expected to have a large impact on future wireless networks. This course is intended for graduate students who have some background on computer networks.

Text Books/Reference Books:

1. "Wireless Communications", Theodore S Rappaport.
2. "Fundamentals of Wireless Communications", David Tse.
3. "Wireless Communications and Networks", W. Stallings, Prentice Hall, 2002.
4. "Wireless Communications: Principles & Practice", T.S. Rappaport, Second Edition, Prentice Hall, 2002.
5. "Mobile Communications", J. Schiller, Addison Wesley, 2000.
6. "IS-95 CDMA and cdma 2000", V.K. Garg, Prentice Hall PTR, 2000.
7. "The UMTS Network and Radio Access Technology - Air Interface Techniques for Future Mobile Systems", J.P. Castro, Wiley, 2001.
8. "WCDMA for UMTS Radio Access for Third Generation Mobile Communications", H. Holma and A. Toskala, John Wiley & Sons, 2001

Course Name: Telecommunication Systems

Course Structure: Lectures:3 Labs: 0 **Credit Hours:** 3

Objectives: To provide a first level exposure to the broad domain of telecommunication Systems

Course Outline: Introduction to media, bandwidth and noise. Twisted pair (UTP, STP), coaxial cables (types and specifications), optical fibres (types and losses), Introduction to optical sources and detectors. Microwave links, satellite communication and infrared

links. Frequency Division Multiplexing (FDM), TDM, FDMA, TDMA and CDMA. Switching: circuit and packet switching. Introduction to mobile and cellular communications. Block diagram and current trends.

Reference Material:

1. "Introduction to Telecommunications Network Engineering", 2nd edition, T. Aattalainen, Artech House 2003, ISBN: 1580535003.
2. "Fundamentals of Telecommunication Networks", T. Saadawi, Wiley US, ISBN: 0471515825.
3. "Telecommunication Systems", P. G. Fonteolliet, Artech House 1991.

Course Name: Systems Programming

Course Structure: Lectures: 2, Labs: 1 **Credit Hours: 3**

Prerequisites: Operating Systems

Objectives: Demonstrate mastery of the internal operation of Unix system software including assemblers, loaders, macro-processors, interpreters, inter-process communication.

Course Outline: System Programming overview: Application Vs. System Programming, System Software, Operating System, Device Drivers, OS Calls. Window System Programming for Intel386 Architecture: 16 bit Vs 32 bit, Programming, 32 bit Flat memory model, Windows Architecture. Virtual Machine (VM)Basics, System Virtual Machine, Portable Executable Format, Ring O Computer, Linear Executable format, Virtual Device Driver (V + D), New Executable format, Module Management, COFF obj format 16 bit. (Unix) other 32-bit O.S Programming for I 386; Unix Binaryble format (ELF), Dynamic shared objects, Unix Kernel Programming (Ring O), Unix Device Architecture (Character & Block Devices), Device Driver Development, Enhancing Unix Kernel.

Reference Material:

1. "The UNIX Programming Environment", B. Kernighan & R. Pike Prentice-Hall.
2. "System Software", Leland L. Beck, Addison-Wesley Longman, 1990, ISBN: 0-201-50945-8.

Course Name: Distributed Database Systems

Course Structure: Lectures: 2 , Labs: 1 **Credit Hours: 3**

Prerequisites: Database Systems

Objectives: To clearly describe the difference of Centralized database and Distributed database and enable the students to design/model a distributed database.

Course Outline: Introduction, Overview of relational DBMS and Normalization, Distributed DBMS architecture, Distributed database design and Data Distribution Strategies, Replication/Fragmentation, Distributed Transaction Management, Distributed Query Processing, Distributed Concurrency Control, Distributed Data Security, Distributed Database Recovery.

Reference Material:

1. "Principals of Distributed Database Systems", Ozsu Tamer.
2. "Database Systems", Thomas Connolly.

Course Name: Data Warehousing

Course Structure: Lecture: 3

Credit Hours: 3

Prerequisite: Database Systems

Objective: To provide the Introduction of Data warehouse and its purpose. And enable the students to understand different features / issues in data warehousing and its designing.

Course Outline: Introduction to Data Warehouse and Data Marts, Comparison of OLTP Systems & Data Warehousing, Data Warehouse Architecture, Dimensional Modeling, Comparison Of DM & ER Models, Extraction, Cleansing and Loading process and techniques, Designing a Data warehouse, End user tools, OLAP.