

GURU KASHI UNIVERSITY



Diploma in Computer Applications

Session 2025-26

Faculty of Computing

Semester-I									
Course Code	Course Title	Type of Course							
			L	T	P	Cr.	Int	Ext	Total Marks
DCA101	Fundamentals of Computer	Core	4	0	0	4	30	70	100
DCA102	Operating Systems	Core	4	0	0	4	30	70	100
DCA108	Fundamentals of Web Technology	Core	4	0	0	4	30	70	100
DCA103	Effective Communication Skills	Compulsory Foundation	4	0	0	4	30	70	100
DCA109	Fundamentals of Web Technology Lab	Technical Skill	0	0	6	3	30	70	100
DCA106	Effective Communication Skills Lab	Technical Skill	0	0	4	2	30	70	100
DCA105	Office Automation Systems Lab	Compulsory Foundation	0	0	6	3	30	70	100
Total			16	0	16	24	210	490	700

Semester-II									
Course Code	Course Title	Type of course							
			L	T	P	Cr.	INT	EXT	Total Marks
DCA202	Programming in C	Core	4	0	0	4	30	70	100
DCA203	Data Structures	Core	4	0	0	4	30	70	100
DCA207	Database Management Systems	Core	4	0	0	4	30	70	100
DCA204	Programming in C Lab	Technical Skill	0	0	6	3	30	70	100
DCA208	Database Management Systems Lab	Technical Skill	0	0	6	3	30	70	100
DCA209	PC Assembling & Troubleshooting Lab	Technical Skill	0	0	6	3	30	70	100
DCA210	Digital Electronics	VAC	2	0	0	2	30	70	100
Total			14	0	18	23	210	490	700
Grand Total			30	0	34	47			

SEMESTER-I

Course Title: Fundamentals of Computer	L	T	P	Cr.
Course Code: DCA101	4	0	0	4

Total Hours: 60

Course Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Describe basic computer structure, number systems, and binary arithmetic.
- CO2. Identify computer codes and input/output devices.
- CO3. Explain memory types, storage devices, and programming languages.
- CO4. Discuss software types, Internet basics, and virus protection.

Course Content**UNIT I****15 hours**

Computer fundamentals: Characteristics Of Computers, Generations Of Computers, Block Diagram Of A Computer **number system:** Bit, Byte, Binary, Decimal, Hexadecimal, And Octal Systems, Conversion From One System To The Other, Representation Of Characters, Integers And Fractions **Binary Arithmetic:** Addition, Subtraction And Multiplication

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UNIT II**15 hours**

Computer Codes: weighted and non-weighted code, BCD, EBCDIC, ASCII, Unicode. Input Devices: Keyboard, Mouse, Joy tick, Track Ball, Touch Screen, Light Pen, Digitizer, Scanners, Speech Recognition Devices, Optical Recognition devices – OMR, OBR, OCR **Output Devices:** Monitors, Printer and its Types.

UNIT – III**15 hours**

Memories: Units of Memory, Main Memories - RAM, ROM and Secondary Storage Devices - Hard Disk, Compact Disk, DVD.

COMPUTER LANGUAGES: Machine language, assembly language, higher level language, 4GL.

UNIT – IV**15 hours**

Introduction to Compiler, Interpreter and Assembler. **Computer Software:** Need, Types – System software, **Application software** **Internet:** Basic Internet terms: Web Page, Website, Home page, Browser, URL, Hypertext,

Web Server, Applications: WWW, e-mail, Instant Messaging, Videoconferencing. Computer Virus, Types of Viruses Virus detection and prevention.

Suggested Readings

1. P.K. Sinha and P. Sinha (2002), *Foundations of Computing*, First Edition, BPB.
2. D. H. Sanders (1988), *Computers Today*, Fourth Edition, McGraw Hill.
3. V. Rajaraman (1996), *Fundamentals of Computers*, Second Edition, Prentice Hall of India, New Delhi.
4. Satish Jain (1999), *Information Technology*, Paperback Edition, BPB.

Course Title: Operating Systems	L	T	P	Cr.
Course Code: DCA102	4	0	0	4

Total Hours: 60

Course Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Define operating system concepts, functions, and types.
- CO2. Explain process management, scheduling, and deadlock handling.
- CO3. Describe memory management techniques and virtual memory.
- CO4. Discuss secondary storage structure, disk scheduling, and management

Course Content

UNIT-I **15 hours**

Introduction: Operating system Meaning, Supervisor & User mode, Operating system operations & Functions, Types of OS.

UNIT-II **15 hours**

Process Management: Process Concept, PCB, Process Scheduling, Cooperating Processes, Overview of Inter Process Communication, Context Switching, scheduling criteria, **Type Of Scheduling:** Long term, Short term & Medium term scheduling, scheduling algorithms, Deadlock concept & handling.

UNIT-III **15 hours**

Memory Management: Logical & Physical Address space, Swapping, Contiguous memory allocation, paging, segmentation, Virtual memory, demand paging, Overview of Page replacement, Thrashing.

UNIT-IV **15 hours**

Secondary Storage Structure: disk structure, Disk Scheduling, disk management, swap space management.

Suggested Readings

1. Tanenbaum, A. (2009). *Modern operating systems*. Pearson Education, Inc.,.
2. Coffman, E. G., & Denning, P. J. (1973). *Operating systems theory* (Vol. 973). Englewood Cliffs, NJ: prentice-Hall.
3. Madnick, S. E., & Donovan, J. J. (1974). *Operating systems* (Vol. 197, No. 4). New York: McGraw-Hill.
4. Deitel, H. M. (1990). *An introduction to operating systems*. Addison- Wesley Longman Publishing Co., Inc.

Course Title: Fundamentals of Web	L	T	P	Cr.
Course Code: DCA108	4	0	0	4

Total Hours: 60

Course Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Explain the basics of the Internet, browsers, and common HTML tags.
- CO2. Develop structured web pages using HTML and XHTML elements.
- CO3. Apply cascading style sheets for styling and layout of web pages.
- CO4. Use JavaScript and DOM to add interactivity and content to web pages.

Course Content

UNIT I

15 hours

Basics of Internet and Web The basics of Internet, World Wide Web, Web page, web browsers, URL, MIME, HTTP, Web Programmers Toolbox.

Web Design: Web site design principles, planning the site and navigation

UNIT II

15 hours

Introduction To Html: List, Tables, images, forms, frames, Basics of CSS and types of CSS. **Introduction to XHTML:** XML, Move to XHTML, Meta tags, Character entities, frames and frame sets, inside browser.

UNIT - III

15 hours

Cascading Style Sheet: Introduction and levels of cascading Style Sheet Style Specification Formats, Styles Classes, properties and properties value, color, and <div> tags.

UNIT - IV

15 hours

Introduction To Java Script: Basic of Java Script and Document Object Model, Element Access in Java Script, event and event handling, Dom event and element Positioning, Moving Element and Element Positioning, Changing Color and Font. Dragging and Dropping Elements

Suggested Readings

1. P.K. Sinha and P. Sinha (2002), *Foundations of Computing*, First Edition, BPB.
2. D. H. Sanders (1988), *Computers Today*, Fourth Edition, McGraw Hill.
3. V. Rajaraman (1996), *Fundamentals of Computers*, Second

Edition, Prentice Hall of India, New Delhi.

4. Satish Jain (1999), *Information Technology*, Paperback Edition, BPB.

Web Sources:

1. <https://www.geeksforgeeks.org/web-technology/>
2. <https://genuinenotes.com/wp-content/uploads/2020/02/Web-Technology-Notes-all.pdf>
3. https://www.rgm cet.edu.in/assets/img/departments/CSE/materials/R_15/3-2/Web%20Technologies.pdf
4. [https://studyglance.in/lecturenotes/display.php?tno=8&subject=Web%20Technologies&title=Web%20Technologies%20\(UNIT-2%20\)%20Lecture%20Notes](https://studyglance.in/lecturenotes/display.php?tno=8&subject=Web%20Technologies&title=Web%20Technologies%20(UNIT-2%20)%20Lecture%20Notes)

Course Title: Effective Communication	L	T	P	Cr.
Course Code: DCA103	4	0	0	4

Total Hours:60

Course Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Use correct English grammar and read with understanding.
- CO2. Communicate effectively in business settings.
- CO3. Apply nonverbal and presentation skills.
- CO4. Improve reading and writing for jobs and formal tasks.

Course Content

UNIT I

15 hours

English Language: Sentence, Parts of speech, Tenses, Active passive voice, Direct/Indirect speech, Creative writing & vocabulary, Comprehension passage, Reading of Biographies of at least 10 IT business personalities.

UNIT – II

15 hours

Business Communication: Types, Medias, Objectives, Modals, Process, Importance Understanding Barriers to communication & ways to handle and improve barriers.

Listening Skills: Its importance as individual and as a leader or as a worker, Types of listening and Traits of a good listener, Note taking, barriers to listening & remedies to improve listening barriers

UNIT – III

15 hours

Nonverbal Communication- understanding what is called nonverbal communication, its importance as an individual, as a student, as a worker and as a leader, its types.

Presentation Skills-Its Purpose in business world, how to find material for presentation, how to sequence the speech with proper introduction and conclusion, how to Prepare PPT & Complete set of required body language while delivering presentation.

UNIT IV

15 hours

Reading Skills- to enhance independent reading, Comprehension Passages, News / Magazine articles on stereotype topics, Poems – Abu Ben Adhem, The Tiger **Writing Skills-** Importance of reading and writing, improving writing skills through Basic cohesive paragraph writing, Resume writing, Job application writing/acceptance letter

Suggested Readings

1. Kumar, S., &Lata, P. (2011). Communication skills. Oxford University Press.
2. Training, M. T. D. (2012). Effective communication skills. Bookboon.
3. Hargie, O. (Ed.). (1986). The handbook of communication skills (p. 37). London: Croom Helm.

Course Title: Fundamentals of Web Technology Lab	L	T	P	Cr.
Course Code: DCA109	0	0	6	3

Total Hours: 90

Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Design basic HTML web pages with color, images, and headings.
- CO2. Create lists, tables, and nested lists using HTML tags.
- CO3. Develop web pages with frames, links, and style sheets.
- CO4. Build simple forms for user input and data collection.

List of Experiments

1. Create a Basic HTML Page using Headings, Paragraphs, and Lists
2. Design a Personal Profile Page using HTML
3. Create a Student Registration Form using HTML Form Elements
4. Create a Table to Display Student Marks with Rowspan and Colspan
5. Build a Navigation Menu using HTML and Inline CSS
6. Apply Internal and External CSS to Style a Webpage
7. Design a Login Page Layout using CSS
8. Create a Responsive Web Layout using Flexbox/Grid
9. Design a Product Card with Image, Price, and Button using CSS
10. Create an Image Gallery Layout using CSS Grid
11. Validate a Registration Form using JavaScript
12. Create a Simple Calculator using HTML, CSS, and JavaScript
13. Build a To-Do List App with Add and Delete Task Options
14. Create an Image Slideshow/Carousel using JavaScript
15. Design a Multi-section Responsive Website with Navigation and Footer

Course Title: Effective Communication Skills Lab	L	T	P	Cr.
Course Code: DCA106	0	0	4	2

Total Hours: 60

Learning Outcomes: After the completion of the course the learner will be able to

CO1. Apply effective listening skills in academic and technical contexts.

CO2. Communicate confidently through speaking and role play.

CO3. Read and interpret various texts, identifying key vocabulary.

CO4. Write clear, error-free content in different formats.

Course Content

UNIT I

15 hours

Listening Practices: Listen and takes notes of Lecture, Listen and Write appropriate word, Talks on Engineering and Technology, Developing effective listening skills, barriers to effective listening

UNIT II

15 hours

Speaking: Self-Introduction, Role play of Celebrities, Sharing memorable incidents

Reading: Reading Online Blogs, Reading Advertisement in Online, Newspaper archives reading

UNIT III

15 hours

Writing Process Description, narrating experiences, Creating Email blogs, Review Writing – Books, Movies, and Journals

Summarized Activities:

Reading – cloze exercises, identifying redundant words, Jargon words, foreign words, Technical terms

UNIT IV

15 hours

Writing – Error free sentences, Sequential paragraphs, Essay writing on various levels – basic, middle, and advanced

Speaking – Face to face conversation on specific topics, interviewing celebrities, getting acquainted with new people, sharing information with persons from abroad.

Course Title: Office Automation System Lab	L	T	P	Cr.
Course Code: DCA105	0	0	6	3

Total Hours: 90

Learning Outcomes: After the completion of the course the learner will be able to

- CO1. Create and edit documents in MS Word.
- CO2. Design presentations in MS PowerPoint.
- CO3. Use data tools and functions in MS Excel.
- CO4. Apply mail merge, macros, and links in MS Office.

List of Experiments

1. [MS-WORD] Creating, opening, closing, saving and editing a word Document.
2. [MS-WORD] Insert header and footer in the document.
3. [MS-WORD] Create a link between two files using Hyperlink.
4. [MS-WORD] Create a mail-merge and add data of 5 recipients.
5. [MS-WORD] Protect a document.
6. [MS-WORD] Implement macro.
7. [MS-POWERPOINT] Create duplicate slides in PowerPoint. Give an example.
8. [MS-POWERPOINT] Make a master slide.
9. [MS-POWERPOINT] Design a chart of population.
10. [MS-POWERPOINT] Insert Animation.
11. [MS-POWERPOINT] Insert a background in PowerPoint.
12. [MS-EXCEL] How you can filter your data.
13. [MS-EXCEL] Sort data in ascending and descending order.
14. [MS-EXCEL] To show the use of goal seek
15. [MS-EXCEL] To show the use of scenarios.
16. [MS-EXCEL] Perform any 5 Date and Time functions.
17. [MS-EXCEL] Perform any 5 Math & Trig functions.

Semester-II

Course Title: Programming in C	L	T	P	Cr.
Course Code: DCA202	4	0	0	4

Total Hours: 60

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Develop confidence for self-education and ability for life-long learning needed for Computer language.
- CO2. Handle possible errors during program execution.
- CO3. Build logic used in Programming.
- CO4. Design and develop Computer programs, analyses, and interprets the concept of pointers, declarations, initialization, operations on pointers and their usage.

Course Content**UNIT I****15 hours**

Introduction: ANSI C standard, Overview of Compiler and Interpreters, Structure of C Program, Programming rules, Execution

Basic Structure Of C Program: Character set, Identifiers and keywords, constants, variable, Data types, input and output, type conversion, Operators and expressions: Arithmetic, Unary, Logical and Relational operators, assignment operators, Conditional operators, type conversion. Library functions.

UNIT II**15 hours**

Input/ Output In C: Formatting input; output functions. Decision making statements – if, else if

Control Statements: branching, looping using for, While and Do-While statements, nested control structures, switch, break and continue statements.

UNIT III**15 hours**

Arrays: Definition, declaration, assignment, one dimensional and two dimensional arrays.

Strings: input/output of strings, string handling functions, table of strings. **Pointers:** pointer data type, pointer declaration, initialization, accessing values using pointers.

Functions: prototype, definition and call, formal and actual arguments, methods of parameter passing to functions, recursion versus iteration.

UNIT IV

15 hours

Structures And Unions: using structures and unions, comparison of structure with arrays and union.

Files: opening and closing files, Basic I/O operation on files. Storage Classes: automatic, external, static and register variables.

Suggested Readings

1. Balagurusamy, *Programming in C*, Tata McGraw Hill.
2. Kanetkar, Y. (2018). *Let us C*. BPB publications.
3. Hanly, J. R., &Koffman, E. B. (2007), *Problem solving and program design in C*, Pearson Education India.

Course Title: Data Structures	L	T	P	Cr.
Course Code: DCA203	4	0	0	4

Total Hours: 60

Learning Outcomes: On the completion of the course the students will be able to

CO1. Explain types of data structures and analyze algorithm complexity.

CO2. Implement and operate on arrays, stacks, and queues.

CO3. Apply linked lists and trees for efficient data management.

CO4. Perform sorting, searching, and graph traversal algorithms.

Course Content

UNIT I

15 hours

Introduction: definition, various types of data structures, data structure operations, algorithms complexity and Time Space Trade-off.

Arrays And Records: Linear arrays, Representation of linear arrays in memory, Operations on Array, Multidimensional arrays and its implementation, Pointers, pointer arrays, Records.

UNIT II

15 hours

Stacks: Stacks, array representation of stacks, operation on stacks, Polish Notation, Notation conversion, evaluation of postfix expression, Applications of Stack.

Queues: Queues, implementation, operations on queue, Dequeues, Priority queues.

UNIT III

15 hours

Linked Lists: Linked lists, Representation in memory, traversing link lists, operations on link list, overflow and underflow, Memory allocation, Header link list, two way lists.

Trees: Basic terminology, Binary trees and its representation, Complete binary tree, Extended binary tree, linked representation of binary tree, traversing binary tree, searching binary tree, Binary search trees.

UNIT IV

15 hours

Sorting And Searching: Definitions, bubble sort, insertion sort, selection sort, quick sort, merge sort, radix sort, heap sort, Quick Sort, Linear Search, Binary Search.

Graphs: representation of graph, types of Graph, adjacency matrices, path matrix, **Graph traversal:** Breadth first search. Depth first search, shortest path problem: Warshall's algorithm, Dijkstra algorithm.

Suggested Readings

1. Hubbard, J. R. (2007), *[Introduction to] Schaum's Outline of Data Structures with Java*, McGraw-Hill.
2. Horowitz, E., & Sahni, S. (1976), *Fundamentals of data structures* (Vol. 1982), Potomac, MD: Computer science press.
3. Wirth, N. (1985), *Algorithms & data structures*, Prentice-Hall, Inc..
4. Tarjan, R. E. (1983), *Data structures and network algorithms*, Society for industrial and Applied Mathematics.

Course Title: Database Management System	L	T	P	Cr.
Course Code: DCA207	4	1	0	5

Total Hours: 75

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Describe database concepts, architecture, and data models.
- CO2. Design ER/EER diagrams and apply relational model concepts.
- CO3. Develop SQL queries for data definition and manipulation.
- CO4. Apply normalization, transactions, and indexing techniques in database design.

Course Content

UNIT I **15 hours**

Introduction To Databases: Characteristics of database approach, data models, database system architecture, data independence and data abstraction.

UNIT II **20 hours**

Data Modeling: Entity relationship (ER) modeling: Entity types, relationships, constraints, ER diagrams, EER model. **RELATION Data Model:** Relational model concepts, relational constraints, relational algebra.

UNIT III **20 hours**

Sql Queries: SQL data definition, data types, specifying constraints, Queries for retrieval, insertion, deletion, updation, introduction to views

UNIT IV **20 hours**

Database Design: Mapping ER/EER model to relational database, functional dependencies, Lossless decomposition, Normal forms (upto BCNF).

Transaction And Data Storage: Introduction to transaction processing: ACID properties, concurrency control; Introduction to indexing structures for files.

Suggested Readings

- Ramakrishnan, R., Gehrke, J., & Gehrke, J. (2003). *Database management systems (Vol. 3)*. New York: McGraw-Hill.
- Korth F. Henry. *Database System Concepts*, McGraw Hill.
- Lu, G. (1999). *Multimedia database management systems*.

Boston: Artech House.

- *Date, C. J. (1975). An introduction to database systems. Pearson Education India.*

Web Sources

1. <https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/><https://www.javatpoint.com/dbms-tutorial>
2. <https://www.techopedia.com/definition/24361/database-management-systems-dbms>

Course Title: Programming in C Lab	L	T	P	Cr.
Course Code: DCA204	0	0	6	3

Total Hours: 90

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Apply basic programming concepts to perform arithmetic and logical operations.
- CO2. Develop programs using control structures to solve simple computational problems.
- CO3. Implement string and matrix operations using appropriate programming techniques.
- CO4. Design and execute programs to handle arrays, loops, subroutines, and pattern printing.

List of Experiments

1. Program to find sum of two numbers.
2. Program to test whether an entered number is even, odd or zero.
3. Program to test whether an entered number is a prime number or not.
4. Program to print N terms of a Fibonacci Series.
5. Program to find the reverse of a number.
6. Program to check whether a given Number or a given string is palindrome or not.
7. Program to reverse a given string.
8. Program to check whether a given number is prime or not.
9. Program to find the prime numbers up to N.
10. Program to print:


```
*
**
***
****
*****
```
11. Program to search a string in an array using read-data.
12. Program to find the frequency of vowels in a given string.
13. Program to find the frequency of each character in a given string.
14. Program to find greatest in a matrix using subroutine.
15. Program for Matrices Addition. And subtraction.
16. Program for Matrix Transpose.
17. Program to find sum of rows and columns of a matrix.
18. Program to find sum of both diagonals of the matrix.

Course Title: Database Management System Lab	L	T	P	Cr.
Course Code: DCA208	0	0	6	3

Total Hours: 90

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Apply DDL and DML commands to manage database structures and data.
- CO2. Use constraints, operators, and set operations in SQL queries.
- CO3. Develop SQL queries with clauses, inbuilt functions, joins, and views.
- CO4. Implement indexes to optimize database performance.

List of Experiments

1. Introduction to DBMS & SQL.
2. Insert records into a table
3. Retrieve data using SELECT statement
4. Use WHERE clause with conditions
5. Update and delete records in a table
6. To implement Various DDL comments.
7. Implement the DML commands.
8. Study of Various types of data Constraints and implementation.
9. Study of all types of operators.
10. Implement the concept of Set Operators.
11. Explore select clauses -order by, having etc.
12. Implement the concept of Inbuilt Function.
13. Implement the concept of Joins,
14. Implement the concept of views.
15. Implement the concept of Indexes

Course Title: PC Assembling & Troubleshooting Lab	L	T	P	Cr.
Course Code: DCA209	0	0	6	3

Total Hours: 90

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Identify hardware and software components of a computer system.
- CO2. Assemble computer parts and connect peripherals and ports.
- CO3. Install operating systems, applications, and utility software.
- CO4. Configure basic network setups, topologies, and IP settings.

List of Experiments

1. Introduction of Hardware and Software/components of computer.
2. Mother boards, Chipsets & Microprocessor concept & latest available in market.
3. Basics & Types of Floppy drive/HDD/DVD/RAM /SMPS/BIOS.
4. Assembling different parts of computers.
5. Knowing ports, wires attached in the Computer.
6. Installation of OS (Linux/Windows).
7. Installation of application and utility software.
8. Networking Basics: Different types of Topologies and their configuration.
9. Types of Switches, I/O Sockets.
10. Creation of Cross Wires and Direct Cables.
11. IP & Setting up a computer on LAN.

Course Title: Digital Electronics	L	T	P	Cr.
Course Code: DCA210	2	0	0	2

Total Hours: 30

Learning Outcomes: On the completion of the course the students will be able to

- CO1. Explain analog and digital systems and use basic logic gates.
- CO2. Design combinational logic circuits using SOP, POS, K-Map, multiplexers, and demultiplexers.
- CO3. Describe and implement basic flip-flops and latches.
- CO4. Explain and apply analog-to-digital conversion techniques.

Course Content

UNIT I 10 hours

Fundamental Concepts: Introduction to Analog and Digital Systems, Digital Signals, **Basic Digital Circuits:** AND, OR, NOT, NAND, NOR, XOR and XNOR gates.

UNIT II 10 hours

Combinational Logic Design: SOP and POS Representation of Logic functions, K-Map Representation Multiplexers: 4X1, 8X1 and 16X1. DE- MULTIPLEXERS: 1 to 4, 1 to 8 and 1 to 16.

UNIT III 5 hours

Flip-Flops: Introduction, Latch, Clocked S-R Flip Flop, Preset and Clear signals, D-Flip Flop, J-K Flip Flop

UNIT IV 5 hours

Analog To Digital Converters: Quantization and encoding, Parallel- comparator A/D converter, Counting A/D converter.

Transactional Mode

Lecture Method, E-Team Teaching, Video based learning, Demonstration, Peer Discussion, Open talk, Cooperative Teaching, Flipped Teaching, Collaborative Learning.

Suggested Readings

- Jain, R. P. (2003). *Modern digital electronics*. Tata McGraw-Hill Education.
- Maini, A. K. (2007). *Digital electronics: principles, devices and*

applications. John Wiley & Sons.

- *Pedroni, V. A. (2008). Digital electronics and design with VHDL. Morgan Kaufmann.*
- *Balch, M. (2003). Complete digital design: a comprehensive guide to digital electronics and computer system architecture. McGraw-Hill Education.*