A Text Book Of

COMPUTER APPLICATIONS IN PHARMACY

As Per PCI Regulations

FIRST YEAR B. PHARM.
Semester II

Vishwas Bhagat
M. Pharm.
Assistant Professor, Faculty of Pharmacy
R.D's College of Pharmacy,
Bhor, Pune

Dr. Sachin Narkhede
M. Pharm., Ph.D., M.B.M.
Principal, Faculty of Pharmacy
Smt. B.N.B. Swaminarayan Pharmacy College,
Salvav, (Vapi), Valsad, Gujarat

Dipak Kardile
M. Pharm.
Assistant Professor, Faculty of Pharmacy
R.D's College of Pharmacy,
Bhor, Pune

Dr. S. J. Shankar
M. Pharm., Ph.D.
Professor & Head, Dept. of Pharmaceutics,
Vivekananda College of Pharmacy,
Dr. Rajkumar Road, Rajajinagar 2nd Stage, Bangalore

Price ₹ 160.00

NIRALI PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N3940

Computer Applications in Pharmacy **ISBN 978-93-87397-83-5**

Fourth Edition : September 2020

© : Authors

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Authors with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the authors or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

Published By :

NIRALI PRAKASHAN

Abhyudaya Pragati, 1312, Shivaji Nagar
Off J.M. Road, Pune – 411005
Tel - (020) 25512336/37/39, Fax - (020) 25511379
Email : niralipune@pragationline.com

Polyplate

Printed By :

YOGIRAJ PRINTERS AND BINDERS

Survey No. 10/1A, Ghule Industrial Estate
Nanded Gaon Road
Nanded, Pune - 411041
Mobile No. 9404233041/9850046517

➢ DISTRIBUTION CENTRES

PUNE

Nirali Prakashan (For orders within Pune) : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra
Tel : (020) 2445 2044; Mobile : 9657703145
Email : niralilocal@pragationline.com

Nirali Prakashan (For orders outside Pune) : S. No. 28/27, Dhayari, Near Asian College Pune 411041
Tel : (020) 24690204; Mobile : 9657703143
Email : bookorder@pragationline.com

MUMBAI

Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,
Girgaum, Mumbai 400004, Maharashtra; Mobile : 9320129587
Tel : (022) 2385 6339 / 2386 9976
Email : niralimumbai@pragationline.com

➢ DISTRIBUTION BRANCHES

JALGAON

Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra,
Tel : (0257) 222 0395, Mob : 94234 91860; Email : niralijalgaon@pragationline.com

KOLHAPUR

Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank, Kolhapur 416 012
Maharashtra. Mob : 9850046155; Email : niralikolhapur@pragationline.com

NAGPUR

Nirali Prakashan : Above Maratha Mandir, Shop No. 3, First Floor,
Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra
Tel : (0712) 254 7129; Email : niralinagpur@pragationline.com

DELHI

Nirali Prakashan : 4593/15, Basement, Agarwal Lane, Ansari Road, Daryaganj
Near Times of India Building, New Delhi 110002 Mob : 08505972553
Email : niralidelhi@pragationline.com

BENGALURU

Nirali Prakashan : Maitri Ground Floor, Jaya Apartments, No. 99, 6th Cross, 6th Main,
Malleswaram, Bengaluru 560003, Karnataka; Mob : 9449043034
Email: niralibangalore@pragationline.com

Other Branches : Hyderabad, Chennai

Note : Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader must cross check all the facts and contents with original Government notification or publications.

Preface

Welcome to a Text Book of **Computer Applications in Pharmacy**, we created this Book with several goals in mind such as accessibility, customization, and student engagement-helping students reach high levels of academic in a simplest way. We observed that students of pharmacy had a difficult time to understanding the complex language and reading big bulky reference books of pharmacy for their limited syllabus. They require a book that is simple and easy to follow. It's encouraging us to write this book for pharmacy students as per new PCI syllabus.

This book deals with the basic Concepts of Computers, Databases, Database Management Systems, Web Technologies (HTML, XML and CSS), Bioinformatics, Preclinical Development and various Applications of Computers in Pharmacy (Drug Design, Electronic Prescribing, Hospital Pharmacy, Clinical Pharmacy, Diagnostics Systems, PIS, HIS, CDS, TIMS, LIMS, Drug Information, Pharmacy Databases, Bioinformatics Databases and so on). We have attempted to achieve maximum coverage in the simplest way.

Some important features of the book given below:

- Exactly as per syllabus prescribed by Pharmacy Council of India.
- Easy to follow, step wise, self explanatory and student's friendly approach.
- Well labeled diagram.

We would like to thanks all our colleagues for their valuable suggestion to write this book in a simplest way for Pharmacy students in a respective prescribed syllabus.

We are thankful to Shri. Dineshbhai Furia and Shri. Jignesh Furia of Nirali Prakashan, Pune and Staff of Nirali Prakashan for bringing out nicely printed book.

Authors

■■■

Syllabus

UNIT - I **(06 Hours)**

Number System: Binary Number System, Decimal Number System, Octal Number System, Hexadecimal Number Systems, Conversion Decimal to Binary, Binary to Decimal, Octal to Binary etc., Binary Addition, Binary Subtraction – One's Complement, Two's Complement Method, Binary Multiplication, Binary Division

Concept of Information Systems and Software: Information Gathering, Requirement and Feasibility Analysis, Data Flow Diagrams, Process Specifications, Input/Output Design, Process Life Cycle, Planning and Managing the Project

UNIT - II **(06 Hours)**

Web Technologies: Introduction to HTML, XML, CSS and Programming Languages, Introduction to Web Servers and Server Products

Introduction to Databases, MySQL, MS-Access, Pharmacy Drug Database

UNIT - III **(06 Hours)**

Application of Computers in Pharmacy: Drug Information Storage and Retrieval, Pharmacokinetics, Mathematical Model in Drug Design, Hospital And Clinical Pharmacy, Electronic Prescribing and Discharge (EP) Systems, Barcode Medicine Identification and Automated Dispensing of Drugs, Mobile Technology and Adherence Monitoring

Diagnostic System, Lab-Diagnostic System, Patient Monitoring System, Pharma Information System

UNIT - IV **(06 Hours)**

Bioinformatics: Introduction, Objective of Bioinformatics, Bioinformatics Databases, Concept of Bioinformatics, Impact of Bioinformatics in Vaccine Discovery

UNIT - V **(06 Hours)**

Computers as Data Analysis in Preclinical Development: Chromatographic Dada Analysis (CDS), Laboratory Information Management System (LIMS) and Text Information Management System (TIMS)

■■■

Contents

UNIT : I

1.	Number System	1.1 – 1.32
2.	Concept of Information Systems and Software	2.1 – 2.20

UNIT : II

3.	Web Technologies	3.1 – 3.32
4.	Introduction to Databases	4.1 – 4.24

UNIT : III

5.	Application of Computers in Pharmacy	5.1 – 5.20

UNIT : IV

6.	Bioinformatics	6.1 – 6.08

UNIT : V

7.	Computers as Data Analysis in Preclinical Development	7.1 – 7.12

■■■

UNIT : I

Chapter 1...

NUMBER SYSTEM

♦ **CONTENTS** ♦

- *1.1 Introduction*
  - *1.1.1 Basic Concepts of Computers*
- *1.2 Number System*
  - *1.2.1 Decimal Number System*
  - *1.2.2 Binary Number System*
  - *1.2.3 Octal Number System*
  - *1.2.4 Hexadecimal Number System*
  - *1.2.5 Conversions*
  - *1.2.6 Binary Arithmetic*
  - *1.2.7 Complement Arithmetic*
- *Questions*

1.1 INTRODUCTION

The computers has become a very common tool in all areas of science and technology. Computers have revolutionized the world of pharmacy. It is impossible to imagine any future scenario that does not involve the use of new technologies such as automation.

Now-a-days, computers have become the main component of pharmacy practice. Computer applications, which include programs for drug distribution, administration, clinical practice, and ambulatory care, have been developed in each retail pharmacy and for each segment of the hospital pharmacy. It is essential for pharmacists and pharmacy technicians to become computer literate, and comfortable using the common software programs made for pharmacies. Computers can help in reducing errors and potential patient harm by keeping information up-to-date, accessible, accurate, standardized, concise, and correct.

Computers are data processors that receive input, process that input, and produce output. A computer system consists of hardware and software components. Hardware consisting of interconnected electronic devices that control the computer's operations, hardware includes the computer's processor, memory, storage, and input/output devices. Software is a set of instructions that tell the computer's hardware how to operate.

Pharmacy technicians are involved in all aspects of the pharmacy setting's computerization. Hospitals and community pharmacies have been using information systems to improve productivity and the quality of pharmaceutical care for many years. Today, computerized systems create new opportunities for pharmacists and technicians in the health-care delivery process. The network system in hospital pharmacy, computers have created a need for pharmacy operations to link more closely with other departments within the hospital to communicate better and faster.

In large retail pharmacies, networked computers have created much better communication and access to shared data or to the Internet. The processes of dispensing, record keeping, pricing, creating new prescriptions, and refilling prescriptions have become faster, simpler and easier. Computer applications are also helpful in drug use control. The processes of ordering, stocking, mixing medications, and preparing sterile intravenous medications all benefit from the use of computer applications.

In pharmacy, computerization helps pharmacists by providing a systematic method of order entry, development of patient profiles, production of labels, detection of patient's allergies and sensitivities, verification of dosage, and determination of drug-drug and drug-food interactions. The computer also offers pharmacists or technicians the ability to confirm the accuracy of drug dosages, generic and trade names of drugs, contraindications, adverse effects, and other information that is essential to the patient's well-being. Aside from the computer's clinical uses, it is also used to transfer charges to the patient's account, control inventory, and track unused drugs returned to the pharmacy.

1.1.1 Basic Concepts of Computers

Prior to the study of computer applications in Pharmacy, we must understand following terms of a computers:

1. **Information Technology:** Information Technology (IT) is a modern phenomenon that has dramatically changed the daily lives of individuals and businesses throughout the world. IT may be defined as, “the technology which is used to acquire, store, organize, and process data to a form which can be used in specified applications, and disseminate the processed data”.
2. **Computer:** The term computer is derived from the word 'compute' means to 'calculate'. A computer is an electronic machine that accepts data (input) from the user, processes the data by performing calculations and operations on it (processing), and generates the desired results (output). A computer is defined as, “an electronic device that performs a given task on the basis of given instructions”.
3. **Hardware and Software:** Computers work through an interaction of hardware and software. Hardware refers to the physical parts of a computer that we can see as well as touch, including the case (cabinet) and everything inside it. The most important piece of hardware is a tiny rectangular chip inside the computer called the Central Processing Unit (CPU) or microprocessor. It is called the brain of a computer because

it executes instructions and performs calculations. Hardware items such as monitor, keyboard, mouse, printer, and other components are often called hardware devices. Software refers to a set of instructions or programs that instructs the hardware what to do. Computer software is defined as, "a set of instructions that directs a computer to perform specific tasks or operations". Software can be categorized in to two types namely, **system software** and **application software**. System software refers to that collection of programs which co-ordinate the activities at hardware and all programs running on the computer system. Examples, Operating System (OS), Device Drivers, Utility Programs (Norton's Anti-virus and MCafee Anti-virus), Language Translators Programs (Compiler, Assembler and Interpreter). Application software is a general purpose program or a collection of programs written by the users to solve a specific problem. Examples, Word Processors (WordStar and MS-Word), Spreadsheet (Lotus 1-2-3 and Excel), Desktop Publishing (DTP) Software (Coral Draw and PageMaker).

4. **Motherboard:** The motherboard is the main circuit board of a Personal Computer (PC). It is also known as the mainboard or system board. All the circuitry are placed on motherboard.
5. **Bus:** A bus is an electronic line to set of wires or communication paths that carries data and instructions from one place to another in the form of 0's and 1's. The three major system buses are **Address bus, Data bus, Control bus**. The address bus is a uni-directional pathway that carries addresses generated by the microprocessor to the memory and I/O elements of the computer. The data bus is bi-directional in nature. Data flows along the data bus from the microprocessor to memory. The control bus carries the timing and control signals necessary to co-ordinate the activities of the entire system.
6. **Expansion Slots:** Expansion slots are sockets into which adapters are connected.
7. **Power Supply Unit (SMPS):** It changes normal household electricity into electricity that a computer can use.
8. **Sound Card:** A sound card enables a computer to play and record high quality sound.
9. **Port or Connector:** A port is a connector located on the motherboard or on a separate adapter.
10. **Bay:** A bay is a space inside the computer case/cabinet where a hard drive, a floppy drive or a CD-ROM drive sits.
11. **Instruction and Instruction SET:** Computer understands only in terms of 0's and 1's, which is called the machine language. The numbers that represent computer's machine language comes in natural groupings, known as instructions. Processors are built with the ability to execute a limited set of basic operations. The collection of these operations is known as the processor's instruction set.

12. **Units:** Used to measure computer memory:
    - **(i) Bit (Binary Digit):** It is the basic unit of memory. It is the smallest unit of information on a machine and a single bit can hold only one of two values i.e., 0 or 1. Bit is represented by a lower case b.
    - **(ii) Byte:** A unit of 8 bits is known as a byte. Hence, a byte is able to contain any binary number between 00000000 and 11111111. It is represented by an upper case B.
    - **(iii) Kilobyte:** In decimal system, kilo stands for 1000, but in binary system, kilo refers to 1024. Therefore, a kilobyte is equal to 1024 bytes, but it is often used loosely as a synonym for 1000 bytes. It is usually represented by KB.
    - **(iv) Megabyte:** It comprises 1024 kilobytes, or 1,048,576 bytes. However, since this number is hard to remember, a megabyte can be thought of as a million bytes. Megabyte is the standard unit of measurement for RAM and is abbreviated as MB.
    - **(v) Gigabyte:** A gigabyte consists of 1024 megabytes (1,073,741.524 bytes). It is the standard unit of measurement for hard disks and is often abbreviated as GB.
    - **(vi) Terabyte:** The term terabyte refers to 1024 gigabytes of memory. Often abbreviated as TB, terabyte memory is usually associated with super computers only.
13. **Booting:** The act of starting up a computer and loading the system software into memory. Two types of booting are cold booting and warm booting.
14. **Cache:** A section of memory used to temporarily store files.
15. **Data:** It is raw facts that computers can process.
16. **Information:** Processed data is called as information.
17. **Evolution of Computers:** The computers have been with us for a very long time. About 3000 to 5000 years ago, Chinese introduced the 'ABACUS'. It is a manual calculating device. In 1642, a mechanical digital calculator was produced by Blaise Pascal, a French Mathematician. This machine was known as the 'AUDITING MACHINE' because it could only add or subtract. The principle of this machine was similar to a clock work mechanism and the odometer.

    A German Mathematician Baron Gottfried Wilhelm Von Leibniz improved the adding machine by performing multiplication through repeated addition of a number. This machine was called Leibniz's 'RECKONING MACHINE' and it came out in the year 1671.

    In 1820, Thomas de Colmar, a French Engineer, greatly improved the adding machine and produced 'MULTIPLYING MACHINE'. This machine was commercially accepted and more than one thousand machines were sold in the market. Charles Babbage, a

professor of mathematics at the Cambridge University gave the idea of 'DIFFERENCE ENGINE' in the year 1822, which could produce reliable tables. In 1842, Babbage came out with his new idea of 'ANALYTICAL ENGINE' that was intended to be completely automatic. It is for his efforts that be is today known as the 'Father of Modern Digital Computers'.

In 1925, Dr. Vannevar Bush of Massachusetts Institute of Technology (MIT) built an electro-mechanical computer. Dr. Howard Aiken of Harvard University in association with IBM developed a large scale electro-mechanical computer in 1944. The computer nicknamed 'Mark was based on the concept of Charles Babbage's Analytical Engine'. In 1945, Dr. John Atansoff and his assistant Clifford Berry came out with the 'Atansoff-Berry Computer' or ABC. This machine, named after its inventors was capable of solving certain mathematical equations. It used 45 vacuum tubes for internal logic and capacitors for storage.

The first modern electronic computer 'ENIAC' (Electronic Numerical Integrator And Calculator) came into existence in the year 1946. It was developed at the Moore School of Engineering of the University of Pennsylvania, U.S.A. by a design team led by Prof. J. Presper Eckert and John Mauchly. In 1945, Dr. John Von Neumann gave the idea of stored program computer in the sense that the program be stored in the main memory of the computer along with its associated data. 'EDVAC' (Electronic Discrete Variable Automatic Computer) was the first stored program computer. It was developed in 1952.

The basic architecture of the Von Neumann computer consists of a processor and a store connected through a communication channel. The job of the processor is to execute program instructions stored in the memory. The Britisher's developed the 'EDSAC' (Electronic Delay Storage Automatic Calculator) almost simultaneously with EDVAC of U.S.A. It came out in May 1949.

In 1948, a group of scientists at the Manchester University headed by Prof. M.H.A. Neumann designed a small experimental machine based on stored program concept. This machine called as 'MANCHESTER MARK 1' was hardly of any practical use because of its small storage capacity only 32 words. Since, then the technology has advanced at an unimaginable pace. The computer professionals have labelled every new technological development as a new 'GENERATION' in computers.

18. **Generations of Computers:** Evolution of modern computer is commonly considered in terms of generations of computer. The term computer generations is mainly used to help, understand the various improvements that have taken place in computers used over the last few decades. According to the technology used, there are five generations of computers, which are discussed in the following table:

Sr. No.	Generations of Year
1.	**First Generation (1942-1955): Vacuum Tube Based:** The first generation computers were using Vacuum Tubes and machine languages were used for giving instructions. The major first generation computers were UNIVAC-1, IBM-701, IBM-650, ENIAC (Electronic Numerical Integrator And Calculator), EDVAC (Electronic Discrete Variable Automatic Computer), EDSAC (Electronic Delay Storage Automatic Calculator), etc.
2.	**Second Generation (1955-1964): Transistor Based:** In this generation the vacuum tubes were replaced by tiny solid-state components called transistors. Transistors were highly reliable, requires less power and faster than vacuum tubes. High level languages such as FORTRAN, COBOL, BASIC etc. were introduced. Major second generation computers were IBM-1400 series, IBM-7000 series, Honeywell 200, CDC 3600, UNIVAC 1108 etc.
3.	**Third Generation (1964-1975): Integrated Circuit (IC) Based:** The third generation computers used the new technology i.e., Integrated Circuits (IC's) in place of transistors. All electronic components like transistors, resistors and capacitors were fabricated on silicon chips. Operating systems were introduced for use in computers. More high level languages like Pascal, RPG were also introduced. Major third generation computers were PDP-8, PDP-11, IBM-360 series, ICL-2900 series, CDC's CYBER-175, TDC-316, IBM 370/168 etc.
4.	**Fourth Generation (1989-onwards): VLSI Microprocessor Based:** With the advancement of technology for manufacturing ICs, it is possible to integrate 10,000 transistors in an IC. This technology is called Large Scale Integration (LSI). Very Large Scale Integration (VLSI) can pack a million or more transistors on a single chip. LSI and VLSI technologies led to the introduction of Microprocessors. Computers which are designed using Microprocessors become the fourth generation computers. The languages C, LISP, Prolog become popular. Present day computers are fourth generation computers. Major fourth generation computers are APPLE II, IBM 4341, DEC 10, IBM System 370, CRAY–MPC, WIPRO 860, IBM AS/400/B60, IBM ps/2 MODEL 80, HCL Magnum, etc.
5.	**Fifth Generation (1989-onwards): ULSI Microprocessor Based:** In the fifth generation, the VLSI technology became ULSI (Ultra Large Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components. This generation is based on parallel processing hardware and AI (Artificial Intelligence) software. AI is an emerging branch in computer science, which interprets means and method of making computers think like human beings. All the high-level languages like C and C++, Java, .Net etc., are used in this generation. Some computer types of this generation are Laptop, NoteBook, UltraBook and ChromeBook.

19. **Computer System:** A system is a group of element or components that work together to carry out some common tasks and to achieve a common goal or objective. A computer can be viewed as a system, which consists of a number of interrelated components or elements that work together with the objective/goal of converting data into information. A complete computer system consists of four parts components/elements i.e., Hardware, Software, Data and User.
20. **Algorithm:** An algorithm is a procedure consisting of a finite number of precisely defined steps for solving a problem. An algorithm can be defined as, "a step-by-step procedure that provides solution to a given problem".
21. **Flowchart:** A flowchart is a graphic/pictorial representation of the steps necessary to solve a problem. A flowchart can be defined as, "a symbolic representation of a solution of a particular problem".
22. **Program and Programming Language:** A computer language is also known as programming language. A programming language is, "a set of commands, instructions, and other syntax use to create a software program". A program is a set of instructions for performing a particular task. A program is also called as software. The art of writing a program is called as programming. Computer languages may be basically classified in three major categories as described below":
    - **(i) Machine Language:** The set of instruction codes, whether in binary (0 and 1), which can be directly understood by the CPU of a computer without the help of translating program, is called a Machine Language.
    - **(ii) Assembly Language:** The language which substitutes letters and symbols for the numbers in the machine language program is called an Assembly Language or Symbolic Language. A program written in symbolic language that uses symbols instead of numbers is called assembly code or symbolic code i.e. MNEMONICS. such as ADD, SUB, MULTI etc.
    - **(iii) High Level Language:** High level languages are similar to English language. Programs written using these languages can be machine independent. A single high-level statement can substitute several instructions in machine or assembly language. In high-level language, programs are written in a sequence of statements to solve a problem. For example: sub = a – b. Languages such as COBOL, FORTRAN, BASIC, and C are considered high-level languages.
23. **Types of Computers:**
    - **(i) Types of Computers according to Type of Data Handling Techniques:**
        - **(a) Analog Computers:** A computing machine that works on the principle of measuring, in which the measurements obtained are translated into desired data (information) is known as analog computer. Analog computers are used for scientific and engineering purposes. Slide rule, Antikythera mechanism, astrolabe, differential analyzer, Deltar, Kerrison Predictor are the examples of analog computers.