



# SARVAPALLI RADHAKRISHNAN UNIVERSITY, BHOPAL (M.P.)

## B.Pharm.- I Semester

### BPHY-101(A) MATHEMATICS

#### UNIT I

**Algebra:** Equation reducible to quadratics, Simultaneous equations (linear and quadratic), Determinations. Properties of solution of simultaneous equations by Cramer's rule, Matrices, definition of special kinds of matrices, arithmetic operations on matrices, inverse of a matrix. Pharmaceutical applications of determinants and matrices.

#### UNIT II

**Mensuration and its pharmaceutical applications.** Measures of Central Value objectives and pre-requisites of an ideal measure, Mean, Mode and median. Standard deviation and standard error of means, coefficient of variation.

#### UNIT III

**Biometrics:** Significant digits and rounding of numbers, data collection, random and non-random sampling methods, sample size, data organization, diagrammatic representation of data, bar, pie, 2-D and 3-D diagrams, measures of central tendency, measures of dispersion, standard deviation, standard error of means, coefficient of variations, confidence (fiducial) limits.

#### UNIT IV

##### **Calculus:**

**Differential:** Limits and functions, definition of differential coefficient, Differentiation of standard functions including function of a function (Chain rule). Differentiation of implicit functions, logarithmic differentiation, parametric differentiation, successive differentiation.

**Integral:** Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, substitution and partial fractions, formal evaluation of definite integrals.

#### UNIT V

**Correlation and regression:** Method of least squares, statistical inference, Student's and paired t-test, F-test and elements of ANOVA, kurtosis and skewness, Applications of statistical concepts in Pharmaceutical Sciences.

#### **Books Recommended:**

1. Ray M., Algebra.
2. A Textbook of Mathematics for XI-XII Students. NCERT Publications. Vol I-IV 1991
3. Paria G., Differential Calculus, Scholar's Publications, Indore.
4. Paria G., Integral Calculus, Scholar's Publications, Indore.
5. Seshagiri P. Rao, A Textbook of Remedial Mathematics, Ist edition, 2008, Pharma Med Press
6. Bolton's Pharmaceutical Statistics. Practical and Clinical Applications. Marcel Dekker, New York, 1990.



# SARVAPALLI RADHAKRISHNAN UNIVERSITY, BHOPAL (M.P.)

## BPHY-101 (B) REMEDIAL BIOLOGY

### **1. Plant Anatomy and Physiology :**

- i. Morphology and Anatomy of flowering plant and its parts like root, stem, bark, wood, leaf, flower, fruit and seed. Modification of root and stem.
- ii. Transportation, photosynthesis and respiration in plants, Plant growth and development.
- iii. Structure of plant cell, Different types of plant tissues and their functions.

### **2. Structure and functions :**

- i. Cell- the unit of life.
- ii. Biomolecules – Lipids, polysaccharides, Proteins, and nucleic acids. Enzymes and cofactors , their classification , chemistry, mechanism of action and factors affecting enzyme activity.
- iii. Cell cycle and cell division, stages of mitosis and meiosis, and their significance.

### **3. Living systems**

- i. Biological classification – Five kingdoms Monera, Protista, Fungi, plantae and animalia. Viruses, viroids and lichens.
- ii. Animal kingdom - Classification and its basis
- iii. Plant kingdom – Algae, bryophytes, Pteridophytes, Gymnosperms, Angiosperms. Plant life cycles and alteration of generations.

### **4. Genetics and Evolution :**

- i. Principles of inheritance and variation – Mendel's laws, inheritance of one gene and two gene, sex determination, mutation and genetic disorders.
- ii. Molecular basis of inheritance – DNA, RNA, Replication, Transcription, Genetic code, Translation, regulation of gene expression, DNA fingerprinting, Human Genome Project.
- iii. Evolution – Origin of life, theory of evolution of life forms, Evidences for evolution, Adaptive radiation, Biological evolution, Hardy- Weinberg principle.

### **List of Experiments**

1. To study the simple and compound microscope.
2. To study the microscopic section of the Monocot and Dicot plant.
3. To identify the part of the plant by given section (root).
4. To identify the part of the plant by given section (stem).
5. To identify the part of the plant by given section (bark).
6. To identify the part of the plant by given section (leaf).
7. To identify the part of the plant by given section (seed).
8. To identify and differentiate the parts of the given plant sample morphologically.

### **Books Recommended:**

1. Concepts of biology, Enger.
2. Text book of Biology by S.B.Gokhale.
3. Outlines of zoology by M.Ekambaranatha Ayyar and T.N.Ananda Krishnan.
4. A manual for pharmaceutical biology practicals by S.B.Gokhale and C.K.Gokhale.
5. A text book of botany by Linda R. Berg.
6. Cell and molecular biology by Peter J. Russel, Stephen L. Wolfe, Paul E. Hertz.



# SARVAPALLI RADHAKRISHNAN UNIVERSITY, BHOPAL (M.P.)

## BPHY-102 COMPUTER APPLICATIONS

**Introduction to Computer-** Its Types and uses, Computer Generations, Hardware, software, Elements of computer system, Number Systems:- Decimal, Binary, Octal, hexadecimal, Storage Devices- primary memory, Secondary Memory, Input and output devices.

**Operating system-** Basic Concepts, Organization, functions, operations and types, Features of DOS, Windows and Unix operating systems. Dos Commands.

**Data Transmission and Networks-** Basic Concepts LAN, MAN, WAN. Network Topologies, TCP/IP, Worldwide web, URL, HTML. Transmission Media.

**Programming** – High Level languages, Machine languages, Syntax, semantics. Compiler, Interpreter Algorithms and Flowchart.

**Programming Language ‘C’** – Data types, Constants, variables, Operators, symbolic constants, input and output, increment and decrement operators. Control Structures: while, do- while, for, if, if-else, and switch statement. Functions, header files, recursion, pointers and arrays, structures.

**Application software-** Word processing, formatting, printing setups, mail merge, Table Handling, picture handling, spreadsheet programs, workbooks/ worksheets, formatting of sheets, formulae and functions, graphs, Import and export of files / data. Presentation Packages, Slide designing.

### **Practicals:**

Introduction to various components of computer, Use of External & Internal DOS Commands, MS- Office – MS Word, MS, Excel, Power point. A simple documentation preparation & printing. Usage of printer & other components. Simple programs in C.

### **Book Recommended:**

1. V. Rajaraman: Fundamentals of computer, Iind Edition, East Economy Edition.
2. E. Balaguruseamy: Programming In C, TMH Pub
3. D.S. Yadav: Fundamentals of Information Technology, New Age Publication.
4. P.K. Sinha: Fundamentals of Computer
5. Computer Architecture (Schaum’s outline) CARTER, TMH.



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## **BPHY-103 PHARMACEUTICS –I (INTRODUCTION TO DOSAGE FORM)**

1. History of pharmaceutical practice through ages. Various system of medicines. Significance of pharmacopoeias with special reference to Indian, British, United States, International and Extra pharmacopoeias.
2. Routes of administration and classification of pharmaceutical dosage form.
3. Definition, general formulation, principles and procedures adopted for dispensing and official products of the following- Aromatic waters, Solutions, Syrups ,Mixtures, Spirits, Elixers, Linctuses, lotions, liniments, Mixtures, Glycerites, Gargles, Mouth washes, Inhalations powders, Capsules, Tablet triturates, Ointments, Creams, pastes, Suppositories and ophthalmics, Emulsions, Suspension, Milk and Magmas, Mucilages, Jellies, Infusion, Decoctions, Tinctures and Extracts.
4. Pharmaceutical Calculation: Different systems of weights and measures, Dilution and conc. of solutions, Percentage solution, Calculation by allegation, Proof Spirits, Calculation of doses, Displacement value.
5. Detailed methods employed in the preparation of plant extractives.

### **LIST OF PRACTICALS**

1. Study Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia and Extra Pharmacopoeia.
2. Prepare and submit Camphor Water I.P.
3. Prepare and submit Chloroform Water I.P.
4. Prepare and submit Conc. Dill Water I.P.
5. Prepare and submit Aqueous Iodine Solution I.P.
6. Prepare and submit Weak Iodine Solution I.P.
7. Prepare and submit Strong Iodine Solution I.P.
8. Prepare and submit Cresol with Soap Solution I.P.
9. Prepare and submit chloroxylenol Solution I.P.
10. Prepare and submit Simple Syrup I.P.
11. Prepare and submit Simple syrup U.S.P.
12. Prepare and submit Chloroform Spirit I.P.
13. Prepare and submit Simple elixir I.P.
14. Prepare and submit Calamine Lotion I.P.
15. Prepare and submit Calamine Lotion USP, oily.
16. Prepare and submit Turpentine Liniment I.P.
17. Prepare and submit Liquid Paraffin Emulsion I.P
18. Prepare and submit Tragacanth Mucilage I.P.
19. Prepare and submit Milk of Magnesia I.P
20. Prepare and submit Bentonite Magma U.S.P.



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21. Prepare and submit Borax Glycerin I.P.
22. Prepare and submit Tannic acid Glycerin I.P.
23. Prepare and submit Mandle's Paint. B.P.
24. Prepare and submit Simple Linctuses I.P.
25. Prepare and submit Menthol and Eucalyptus Inhalation B.P.C
26. Prepare and submit orange / lemon Tincture I.P.
27. Prepare and submit compound benzoin Tincture I.P.
28. To prepare & submit codeine linctuses NFI , BNF.
29. To prepare & submit zinc sulphate & zinc chloride mouthwash IP.
30. To prepare & submit Potassium permanganate gargle NFI 1979.
31. To prepare & submit salicylic acid lotion BPC.
32. To prepare magnesium trisilicate mixture BPC.
33. To prepare & submit Chalk mixture pediatric BPC.
34. To prepare & submit magnesium hydroxide mixture BP.
35. To prepare & submit castor oil emulsion NFI .
36. To prepare & submit liquid paraffin & magnesium hydroxide emulsion BPC.
37. To prepare & submit lubricating gel.
38. To prepare & submit Peppermint water IP.
39. To prepare & submit sodium chloride solution IP.
40. To prepare & submit sodium chloride mouthwash .
41. To prepare & submit oral rehydration salt BP.
42. To prepare & submit soap liniment.
43. To prepare & submit sodium alginate jelly.
44. To prepare & submit lubricating jelly with cellulose ether base.
45. To prepare & submit compound syrup of ferrous phosphate IP

## **Books Recommended:**

1. Indian Pharmacopoeia.
2. British Pharmacopoeia.
3. United State Pharmacopoeia.
4. Lachmen, L. & Lieberman, H.A., "Theory and Practice of Industrial Pharmacy", Verghese publishing house, Bombay.
5. Gennaro, A.R., Remington's "The Science and practice of Pharmacy", Lippincot, Williams & Wilkins, Philadelphia.
6. Aulton, M.E., "Pharmaceutics- The science of doses form design", Churchill Livingstone, London.
7. Banker and Rhodes, *Modern Pharmaceutics*. Marcel Dekker Inc. NY.
8. Kibbe, " Hand book of Pharmaceutical Excipients., Pharmaceutical Press, London.
9. Martin, *Physical Pharmacy*.
10. N. K. Jain, Text Book of Professional Pharmacy, CBS Publishers & Distributors. New Delhi.
11. N.K. Jain, Pharmaceutical product development, CBS Publishers & Distributors. New Delhi.
12. B. M. Mithal, Text Book of Pharmaceutical Formulation.
13. Pharmaceutical Dosage Forms & Drug Delivery System. Loyd.V.Allen, Jr.Nicholas, G.Popovich, Howad C.Ansel



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## BPHY-104 PHARMACEUTICAL CHEMISTRY I (INORGANIC)

### **1. Elements and periodicity**

Modern periodic law and present form of the periodic table, s, p, d and f block elements, periodic trends in properties of elements- atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity.

### **2. Sources of impurities in pharmaceutical substances**

Importance of limit test and general principles and procedure for limit tests of chloride, sulphate, iron, arsenic, lead and heavy metals.

### **3. Essential and Trace Elements**

Study the role of essential and trace elements in biological systems and their toxicity.

**Major Intra and extra cellular electrolytes:** Major physiological ions, electrolytes used in replacement therapy, physiological acids-base balance, electrolytes used in acid-base therapy, electrolyte combination therapy.

### **4. Inorganic Agents**

Occurrence, preparation, physical characteristics, chemical properties, purity test, incompatibilities, assay and pharmaceutical uses of inorganic official compounds of the following elements; Aluminum, Sodium, Magnesium, Lithium, Calcium, Iron, Copper, Silver, Antimony, Iodine, Boron, Potassium, Zinc, Nitrogen

**5. Reagents:** Preparation, properties and uses of the following reagents; Nessler's reagent, boron trifluoride, Grignard reagent, Potassium permanganate, potassium dichromate, Hydrogen peroxide, Iodine solution.

### **6. Radiopharmaceuticals**

Basic properties, production, quality control, stability, clinical and medicinal applications of radioisotopes used in pharmacy and medicine preparations of diagnostic and therapeutic agents.

## **List of Practicals**

1. Limit test for Lead.
2. Limit test for Arsenic.
3. Limit test for Chloride.
4. Limit test for Sulfate.
5. Limit test for Heavy metals.
6. Standardization of sulphuric acid.
7. Standardization of hydrochloric acid.
8. Standardization of sodium hydroxide.
9. Standardization of potassium permanganate.
10. Standardization of sodium thiosulphate.



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11. Determination of strength of solution of ammonia.
12. Quantitative determination of boric acid.
13. Assay of sodium bicarbonate.
14. Assay of sodium carbonate.
15. Assay of ferrous sulphate.
16. Assay of iodine solutions.
17. Preparation of Alum (potassium and ammonium).
18. Preparation of Ferrous sulfate.
19. Preparation of dibasic calcium phosphate.
20. Preparation of ferric ammonium citrate.
21. Preparation of light and heavy magnesium oxide and
22. Preparation of magnesium carbonate.
23. Preparation of calcium carbonate.
24. Preparation of magnesium trisilicate.
25. Preparation of zinc sulphate.
26. Purification of Copper sulfate.

## **Books Recommended**

1. L.M. Atherdon, Bentley and Drivers: Textbook of pharmaceutical chemistry, Oxford, University press.
2. Pharmacopoeia of India, Govt. of India, Ministry of Health, Delhi.
3. J.H. Block, E. Roche, T.O. Soine and C. O. Wilson: Inorganic Medicinal and Pharmaceutical chemistry, Lee Febiger, Philadelphia. PA.
4. Roger's Inorganic Pharmaceutical Chemistry of Lea and Febiger, Philadelphia, USA.
5. M. Ali: Text book of Pharmaceutical Inorganic chemistry, CBS, New Delhi.
6. Mellor's Modern Inorganic Chemistry, Longman Green and Co., Ltd., London.
7. Atkins P.W. Physical Chemistry, Oxford 1990 2.
8. Barrow G.M. Physical Chemistry, McGraw-Hill 1989
9. Beckett & Stenlake, Practical Pharmaceutical Chemistry
10. Liptrot G.F. Modern Inorganic Chemistry, Blantyre Printing
11. British Pharmacopoeia, Stationary Press, Royal Society of Pharmaceutical Press, London.
12. United State Pharmacopoeia, United State Pharmacopoeial Convention, Inc., 12601. Twinbrook Parkway, Rockville M.D. 20852 USA.
13. Lovis F. Fieser D.C. Experiments in Inorganic Chemistry, Health and Company, Boston.
14. Vogel Text Book of Quantitative Chemical Analysis, Longman, London.
15. Remington Practical of the Science and Pharmacy, Mack Publishing Company, Easton, Pennsylvania, USA.



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## BPHY-105 PHARMACEUTICAL CHEMISTRY II (PHYSICAL CHEMISTRY)

### 1. Atomic, Molecular Structure and Chemical Bonding

#### Atomic Structure

Origin of the elements, valency, the mole concept, molar mass, compounds, chemical formulae. Introduction to atomic structure. Electronic configuration of atoms and relationship to structure of the Periodic Table. Properties of atoms, size, ionization potential, electronegativities etc. Quantum numbers, orbitals and the Aufbau process. Rydberg formula, Bohr atom, dual wave/particle nature of light and electrons. Angular and radial wavefunctions of atomic orbitals. H atom spectrum.

#### Molecular structure and chemical bonding:

LCAO approximation, molecular orbital theory and molecular orbital energy level diagrams. Polarisation and polarisability of molecules. Molecular orbital electronic configuration of homonuclear diatomic molecules. Hydrogen bonding. Valence bond theory- important features, concept of hybridization involving s, p, d and f orbitals, shapes of molecules, VSEPR theory. Electron spin. Polyelectronic atoms and the orbital approximation. Quantum Mechanics

**Postulates of quantum mechanics:** Eigenvalues and expectation values. Time independent Schrodinger equation. The Born interpretation of the wavefunction. Solutions for particles in boxes. Schrodinger equation applied to vibrational and rotational motion. Interelectronic repulsion: SCF methodology and Hartree-Fock wavefunctions. Slater type orbitals. Spin-orbit coupling. Atomic states and Hund's rules.

### 2. Physico-chemical properties of substances

Polarity of substances, dipole moment, dielectric constant, refractive index, optical rotation, density, specific gravity, viscosity, molar refraction, parachor relative permittivity, Bonding and non-bonding interactions, roentgen diffraction, polymorphism, isomorphism, isotropy, anisotropy, liquid crystals.

### 3. Thermodynamics

**Fundamentals of thermodynamics:** System and surroundings, extensive and intensive properties, state functions, types of processes. spontaneity of chemical change; Free Energy. Equilibrium; Enthalpy and Entropy and spontaneous change

**First law of thermodynamics:** Concept of work, heat internal energy and enthalpy, standard state, thermochemistry, thermochemical laws, heat capacity, molar heat capacity, Hess's law of constant heat summation; Enthalpies of bond dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionization and solution.

**Second law of thermodynamics:** Spontaneity of processes;  $\Delta S$  of the universe and  $\Delta G$  of the system as criteria for spontaneity,  $\Delta G^\circ$  (Standard Gibbs energy change) and equilibrium constant.





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**Third Law of Thermodynamics:** calculation of absolute entropies; specific heat; variation in enthalpy with temperature. Helmholtz and Gibbs energies, chemical potential, conception of absolute entropy. Calculations involving entropy and enthalpy; dealing with ions etc. Variation of G and K with temperature: Ellingham Diagrams, Giauque Function.

## 4. Chemical equilibrium

Law of chemical equilibrium, Equilibrium constant, equilibrium degree of conversion and its control by reaction, conditions, LeChatelier principle, standard change of Gibbs energy during reaction, Equilibrium constants and their significance, Factors affecting equilibrium concentration, pressure, temperature, effect of catalyst. Acid-base catalysis, decomposition of medicinal compounds, accelerated stability analysis, kinetics of enzyme catalysed reactions. Integrated rate equations for simple reaction types. Use of integrated rate equations to determine order. Fractional lives. Molecularity *vs.* order Kinetics of more complex reactions: approach to equilibrium, parallel and consecutive reactions. Rate determining step. Steady state approximation and its uses.

Effect of temperature on rate and rate constant. Arrhenius equation, significance of activation energy. Kinetics of reactions in the gas phase - simple collision theory. Reactions in solution - transition state theory. Enthalpy and entropy of activation. Effects of solvent polarity and viscosity on rates of reaction. Further applications of the steady state approximation - radical chain reactions. General definitions. Stoichiometry *vs.* mechanism. Dependence of rate on concentration: rate constant and order of reaction. Experimental determination of rates of reaction. Determination of orders from rate measurements.

## 5. Phase equilibrium

Gibbs phase rule, types of systems, one component equilibrium, Clapeyron and Clausius-Clapeyron equations, two component systems, Henry's law, sparingly miscible liquids, solubility of solid substances, system solid substance - solvent, melts, Raoult's law and its application, cryoscopy and ebullioscopy, osmotic pressure, three component systems, Nernst distribution law, extraction, ternary diagram, system of three liquids, interfacial phenomena, adsorption on solid surfaces. Phase diagram of mixture fractional distillation, eutectic mixtures.

## 6. Surface Chemistry

**Adsorption** : Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids - Freundlich and Langmuir adsorption isotherms, adsorption from solutions.

**Catalysis** : Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzyme catalysis and its mechanism. acid base catalysis, theories of catalysis, catalytic poisoning and Pharmaceutical application of catalysis.



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## 7. States of Matter

**Gaseous State:** Measurable properties of gases; Gas laws - Boyle's law, Charle's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation, Kinetic theory of gases; Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor, van der Waals equation, liquefaction of gases, critical constants.

**Liquid State:** Solutions, Lowering of vapour pressure and Raoult's Law, osmosis and osmotic pressure, measurement of osmotic pressure, isotonic solutions, pharmaceutical applications of osmosis, theories of semipermeable membranes, colligative properties, elevation of boiling point and its experimental determination, depression of freezing point and its determination, distribution law and solvent extraction method, electrolyte and non electrolytes, Debye-Huckel theory, ionic equilibria in blood, characterization of acid base functional groups.

**Solid State:** Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Bragg's Law and its applications, Unit cell and lattices, packing in solids (fcc, bcc and hcp lattices), voids, calculations involving unit cell parameters, imperfection in solids; electrical, magnetic and dielectric properties.

## List of Practicals

1. Determination of specific gravity of liquids using pycnometer and density bottle.
2. To study the effect of salt/Sugar in different concentration on density of water.
3. To study the effect of temperature on density of given liquid .
4. Determination of the viscosity of a liquid by Ostwald viscometer.
5. To study the effect of concentration on viscosity.
6. To study the effect of temperature on viscosity
7. Determination of the percent composition of a mixture of ethanol and water by viscometric method.
8. Determination of the surface tension of a pure liquid by the capillary rise method.
9. To determine the surface tension of liquid using stalagmometer.
10. To study the effect of temperature on surface tension.
11. To study the effect of surfactant on surface tension.
12. Determination of the percentage composition of mixture of ethanol and water by surface tension method.
13. Determination of interfacial tension between benzene and water by the drop size method.
14. Determination of the parachor value of an organic liquid.
15. Determination of solubility of benzoic acid over a range of temperatures and calculation of its heat of solution.
16. Determination of the mutual solubility curve of phenol and water.
17. Preparation of buffer solutions and measurement of pH.
18. Distillation of a mixture.
19. Determination of phase diagram in ternary system containing a single pair of sparingly miscible liquids.
20. Determination of distribution coefficient of substance between two immiscible liquids . (succinic acid between ether and distilled water).



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## **Book Recommended:**

1. P W Atkins, the Elements of Physical Chemistry, 2nd Ed., OUP, 1996
2. P W Atkins, Physical Chemistry 7th Ed., OUP, 2002
3. B G Cox, Modern Liquid Phase Kinetics, Oxford Science Publications, 1994.
4. J.R. Barrante: Physical Chemistry of Life Sciences, Printeil.
5. K.J. Laidler: Physical Chemistry with Biological Applications, Benjamin.
6. S.C. Wallwork: Physical Chemistry for Students of Pharmacy and Biology, Longman.
7. L. M. Atherden: Bentley and Driver's-Textbook of Pharmaceutical Chemistry, Oxford University Press, Delhi.
8. A.J. Mce: Physical Chemistry, E.L. B.S., London.
9. H.H. Willard, L.L. Merritt and J.A. Dean: Instrumental Methods of Analysis, Van Nostrand Reinhold, New York.
10. Samuel Glasstone and David Lewis: Elements of Physical Chemistry, Macmillan Press, London.
11. A.H. Beckett and J.B. Staenlake: Practical Pharmaceutical Chemistry, Vol. I and II. The Athlone Press of the University of London.
12. Gross J.M. and Wiseall B. Principle of Physical Chemistry, Macdonald and Evans Plymouth, England.
13. Gareth Morris J. A Biologists Physical Chemistry, Edward Arnold, London.
14. Martin A.N. Physical Pharmacy, Lea and Febiger, Philadelphia.
15. Chang R. Physical Chemistry with Application to Biological System. Collier Macmillian Publisher, London.
16. Barrow G.M. Physical Chemistry. McGraw-Hill, London.
17. Yadav J.B. Advanced Practical Physical Chemistry, Geol Publisher House, Meenet, India.
18. Vogel's Text Book of Quantitative Inorganic Analysis including Elementary Instrumental Analysis, Longman, London.