**ALAGAPPA UNIVERSITY, KARAIKUDI**

**NEW SYLLABUS UNDER CBCS PATTERN (w.e.f. 2017-18)**

**M.Phil., PHYSICS - PROGRAMME STRUCTURE**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sem.** | **Course Code** | **Name of the Course** | **Cr.** | **Contact Hours/**  **week** | **Max. Marks** | | |
| **Int.** | **Ext.** | **Total** |
| I | 7PPH1C1 | **Core I** – Research Methodology and Data Analyses | 6 | 10 | 25 | 75 | 100 |
| 7PPH1C2 | **Core II** – Advanced Instrumentation Techniques | 6 | 10 | 25 | 75 | 100 |
| 7PPH1C3 | **Core III** – Professional Competencies | 6 | 10 | 75 | 25  (Viva- Voce) | 100 |
| **Total** | | | **18** | **30** | **--** | **--** | **300** |
| II | 7PPH2C1/  7PPH2C2/  7PPH2C3/  7PPH2C4/  7PPH2C5/  7PPH2C6 | **Core IV** –  (1) Solar Energy and its Utilization  **(or)**  (2) Thin Film Technology  **(or)**  (3) Solid State Ionics  **(or)**  (4) Crystal Growth Methods  and Characterization  Techniques  **(or)**  (5) Principles of Nanomaterials &Technology  **(or)**  (6) Biophysics and  Biomaterials | 6 | 10 | 25 | 75 | 100 |
| 7PPH2DV | **Core V** – Dissertation and  Viva Voce | 12 | 20 | 150 Dissertation  50 Viva-voce | | 200 |
| **Total** | | | **18** | **30** | **--** | **--** | **300** |
| **Grand Total** | | | **36** | **60** | **--** | **--** | **600** |

**I YEAR - I SEMESTER**

**COURSE CODE: 7PPH1C1**

**CORE COURSE – I - RESEARCH METHODOLOGY AND DATA ANALYSES**

**Unit I - Working on a Research Problem**

Scientific research – Aim and motivation – Principles and ethics – identification of research problem – Determining the mode of attack – Current status – Literature survey – Abstraction of a research paper.

Access using internet web tools – e-mail – impact and usefulness of the research problem – Role of research guide – Guidance and rapport – Preparation and presentation of Scientific reports: need and methods – power point and poster – writing of Synopsis and dissertation and thesis.

**Unit II - Data Analysis**

Introduction – statistical description of data – Mean, Variance, Skewness, median, mode – Distributions. Student’s t-test, F-test, chi-square test – Linear and rank correlations – Modelling data: Least-squares fitting data.

**Unit III - Computer oriented numerical methods**

Solution of equations – Simple iterative method – Newton – Raphson method – Numerical integration – Simpson’s rule – Runge-Kutta method.

Gaussian quadrature – solution to simultaneous equations – Gauss-Jordan elimination method– Eigen values and Eigen vectors by matrix diagonalisation (Jacobi method).

**Unit IV - Probability and Correlation**

Meaning of Probability - Binomial - ,Poisson,Chi Square,”t: and F testsfor Small and Large Samples- Usefulness of These Measures in Research.

Meanini of Correlation Analyses – Types of Correlation - Interpretation of ‘r’ in Analyses - Application of Correlation in Empirical Works and in Decision Making.

**Unit V - Regression Analyses**

Methods of Estimation of Regression Co efficient Simple Linear Regression Model,Multiple Linear Regression Model – Interpretation of Regression Co efficientsR2 and Adjusted R2 – Computing Different Growth Rates.

**Books for Reference:**

1. V.Anderson, B.H.Durston and M.Poole, Thesis and Assignment Writing, Wiley Eastern, New Delhi 1977.
2. Rajammal Devadas, Hand Book of Methodology of Research, RMM Vidyalaya Press 1976.
3. C.R.Kothari, Research Methodology: Methods and Techniques,New Age International, New, 2006.
4. H.K.Dass, Mathematical Physics, S.Chand & Company, New Delhi, 2003
5. N. Balagurusamy, Numerical Methods –TMH Publication, 2000
6. Introductory methods of Numerical Analysis, S.S. Sastry, PHI Ltd 3rd edition, 2003.
7. Agarwal Y.P.Concepts,Applications &Computations, Sterling Publishers, New Delhi 1998.
8. Gupta.S.C Damodar Gujarath,. Basic Econometrics,. Tata Mcgraw Hill, New Delhi, 2013.
9. Statistical Methods, Gupta .S.P, S.Chand and Company, New Delhi, 2009.
10. T Murry R. Spiegel Theory and Problems of Statistics, Scham’s Outline Series, McGraw Hill, International Book Company, Singapore, 2012.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - I SEMESTER**

**COURSE CODE: 7PPH1C2**

**CORE COURSE - II – ADVANCED INSTRUMENTATION TECHNIQUES**

**Unit I - Structural Analyses**

X-ray diffraction: Coherent scattering of x-rays, reflected intensities, experimental methods of crystallography, particle size determination.

Spectroscopy: Fourier Transform Infrared (FTIR) and Raman Spectroscopy, Nuclear Magnetic Resonance (NMR),Electron Spin Resonance(ESR)-Principles,Construction, Operation.

**Unit II - Optical and Electrical Characterization**

Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Transmission Electron Microscopy (STEM), Scanning Tunneling Microscopy(STM),Atomic Force Microscopy(AFM)-Principles,Construction, Operation.

Electrical resistivity and conductivity measurement – Two probes, Four probes and Vander Pauw methods – Dielectric constant measurements – Microhardness measurements. Techniques for measurements of Hall Effect.

**Unit III - Thermal Analyses**

Thermal Analysis: Differential Thermal Analysis (DTA), Differential Scanning Calorimetry(DSC), Thermal Gravimetric Analysis(TGA)- Principles, Construction, Operation.

**Unit IV - Compositional Analyses**

AAS Analyses, AES Analyses, Flame Photometry Analyses, ICP AES Analyses, EDAX Analyses- Principles ,Construction ,Operation.

**Unit V - Vacuum Techniques**

Kinetic Theory of gases – Gas Transport and Pumping – Equation of state for ideal gases ,real gases ,velocity and speed of gas molecules, the mean free path, volume occupied by gas molecules. Basic theory of pumping: Basic definitions, resistance and conductance of arbitrary vacuum pipe, fundamental equation of vacuum technique, regions of gas flow in pipes, calculation of pump down time. Vacuum Pumps – Rotary, Diffusion and Turbo molecular Pumps–Principles , Construction,Operation of pump and their salient features-Vacuum gauges-Pirani and Penning Gauges**.**

**Books for Reference:**

1. H.H. Willard, L.L.Merrit J.A.Dean, F.A.Settle , Instrumental Methods of Analysis, CBS Publication and Distributers, New Delhi, 1986.
2. Ganzalex R.C , Woods R.E, Digital Image Processing –3rd edition, Prentice-Hall, 2008.
3. V Alexander Roth, Vacuum Technolog, Edition-2, North-Holland Pub. Co., 1990

♣♣♣♣♣♣♣♣♣♣

**I YEAR - I SEMESTER**

**COURSE CODE: 7PPH1C3**

**CORE COURSE - III – PROFESSIONAL COMPETENCIES**

**Unit I - Editors and Word Processors**

Basic concepts – MS-Word – Creating a document – font style – font size – Edit and format a document – copy, paste, cut, spell check, paragraph and page formatting – shortcut keys – toolbars – customizing tools – Enhance a document file using graphics tools – word act – create headers, footers, page numbers, line spacing, table creation, table formula and sorting, insert chart, insert equation using equation editor. Mail merge feature – printing documents.

**Unit II – Spreadsheets**

MS-Excel – label, number and formula – cell formatting – creating worksheet, Entering data into worksheet, various Data types – using different features with Data, Cell and Text. Opening and moving text in worksheet, cell and cell reference, Toolbar and menus, important functions like SUM, AVERAGE, COUNT etc. formatting a Worksheet & creating graphic objects – creating charts (graphs).

**MS-Access:** Concepts of Database Management – Tables, Queries, Form, Reports, Creating and Editing Database, Customizing tables, Designing and using forms, Querying a database & Generating Reports, OLE etc.

**Unit III - Communication Skills in English**

Understanding communication – greeting and introducing – making requests – asking for and giving permission – offering help – art of small talk – participating in conversation – making a short formal speech – Telephone skills: handling calls, leaving message and making request written communication, report writing, note making – career skills: curriculum vitae – facing an interview and presentation skills.

**Teaching Skills:** Educational Technology – concept, emerging technologies – New technologies on methodology of teaching, learning experiences and curriculum development. Micro-teaching, meaning, teaching, skill of stimulus variation questioning, explanation, reacting, linking and benefits.

**Unit IV - GRE Quantitative Reasoning**

Introduction – foundations and content Review – comparison – problem solving – Data interpretation – Reasoning and Practice set.

**Unit V - Verbal Reasoning and Analytical Writing**

Introduction – Verbal foundation and content view Text completion– sentence equivalence – Reading comprehension – reasoning practice set.

**Analytical Writing:** Introduction – foundation and content view – Issue essay – Argument essay – Analytical practice set.

**Books for Reference:**

1. V.Rajaraman, Fundamental of Computers, B.P.B Publication, 2010.
2. Ronmans field, Working in MS OFFICE, TMH 2004
3. Harry Chambers, Communication Skills For Scientific & Technical Professional Basic Book Press, 2001
4. Alan Barker, Improve Your Communication Skills, Kogan , 2000.
5. Libby Kuonin Early, Communication Skills For Children With Down Syndrome, Wood Fine House, 2003
6. Dutt, A Course In Communication Skills, Ebek Publications, Bangalore, 2007
7. Sharon Weiner Green and Ira K Barron’s, The leader in Test preparation (GRE), Galgotia Publication Pvt. Ltd, 2008.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C1**

**CORE COURSE - IV (1) – SOLAR ENERGY AND ITS UTILIZATION**

**Unit I - Radiation Geometry**

Basis earth sun angles – Determination of Solar time – Derived Solar angles – Day length – Solar Radiation measurements – selective surfaces – Heat balance energy lost by radiation, convection and conduction – Physical characteristics of selectives surface – Anti reflection coatings – Solar reflector materials – production methods of coatings.

**Unit II - Fundamentals of Heat Transfer**

Transfer of Heat by Conduction: Study heat flow in a slab-steady heat flow in a cylindrical shell – Heat transfer through fins – Transient heat conduction

Thermal Radiation: Basic laws of radiation – Radiant heat transfer between two black bodies– Radiant heat transfer between grey bodies.

Convention heat loss Evaluation of convective heat transfer co-efficient – Free convection from vertical planes and cylinders – Forced convection – Heat transfer for fully established flow in tubes.

**Unit III - Solar Thermal Systems**

General description of plate collector – thermal losses and efficiency of FPC – Energy balance equation – Evaluation of overall loss coefficient – Thermal analysis of flat plate collector and useful heat gained by the fluid performance of solar air heaters – Heating and drying of agricultural products Types of drier in use.

Solar concentrators and Receiver geometries – General characteristics of focusing collector systems Evaluation of optical losses – Thermal performance of focusing collectors.

**Unit IV – Photovoltaics**

Description of the photovoltaic effect – Electrical characteristics calibration and efficiency measurement – silicon solar energy converters – Thermal generation of recombination centers silicon.

Role of thin films in solar cells Properties of thin films for solar cells CdSe, Cete, In P, Ga As, Cd Cu2, Cu In SnO2, Cd2SnO4 ZnO – Transport properties of meal films – poly crystalline film silicon solar cells (Photovoltaic characteristics, junction analysis loss mechanisms) Amorpho silicon solar cells (Structural compositional optical and electrical properties).

**Unit V - Energy storage and solar applications**

Types of energy storage Thermal storage Latent heat storage – Electrical storage Principle of operation of solar ponds – Non convective solar ponds – Theoretical analysis of solar pond – so distillation – solar cooking – solar pumping.

**Books for Reference:**

* 1. GD. Rai, Solar Energy Utilization, Khanna Publications, 3 rd Edition, 1996.
  2. H.P.Garg ,Treatise On Solar Energy -Volume I Fundamentals Of Solar Energy, 1982
  3. Charles E. Backus, Solar Cells, IEEE Press, 1976.
  4. Kasturi Lal Chopra and Suhit Ranjan Das, Thin Film Solar Cells, Springer, 1983.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C2**

**CORE COURSE - IV (2) – THIN FILM TECHNOLOGY**

**Unit I - Preparation**

Theories of thin film nucleation – Four stages of film growth incorporation of defects during growth.Spray pyrolytic process – characteristic feature of the spray pyrolytic process – ion plating – Vacuum evaporation – Evaporation theory – The construction and use of vapour sources – sputtering Methods of sputtering – Reactive sputtering – RF sputtering – DC planar m magnetron sputtering.Principles and method of CVD techniques.

**Unit II - Thickness Measurement**

Thickness measurement: electrical methods – optical interference methods – multiple beam interferometry – Fizeau – FECO methods – Quartz crystal thickness monitor.

**Unit III - Electrical properties**

Sources of resistivity in metallic conductors – sheet resistance – Temperature coefficient of resistance (TCR) – influence of thickness on resistivity – Hall effect and magneto resistance – Annealing – Agglometation and oxidation.

**Unit IV - Transport properties**

Semiconducting films: Theoretical considerations – Experimental results –Photoconduction – Field effect thin films – transistors, Insulation films Dielectric properties – dielectric losses – Ohmic contracts – Metal – Insulator and Metal – metal contacts – DC and AC conduction mechanism

**Unit V - Optical properties**

Thin film optics – Theory – Optical constants of thin films – Experimental techniques – Multilayer optical system – interference filers – Antireflection coating, Thin films solar cells: Role, Progress and production of thin solar cells – Photovoltaic parameter, Thin film silicon (Poly crystalline) solar cells: current status of bulk silicon solar cells – Fabrication technology– Photo voltaic performance: Emerging solar cells: GaAs and CulnSe.

**Books for Reference:**

1. LI Maissel and R Clang, Hand Book of Thin films Technology, PHI Press, 2002.
2. K L Chopra, Thin film Phenomena. Malabar : Robert E. Krieger Publishing Company, 1998.
3. Ed George Hass, Physics Of Thin Films, Springer, 2000
4. Berry, Koil and Harris, Thin Films Technology, PHI Press, 1988

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C3**

**CORE COURSE - IV (3) – SOLID STATE IONICS**

**Unit I - Basics of Ionic Conducting Materials**

Ionic conductivity- Normal and super ionic conductors differences-Mass transport in crystals – Diffusion- Atomic Diffusion theory – experimental determination of the diffusion constant –Ionic conduction- Experimental results – Einstein relation – Dielectric loss in ionic crystals – Electronic conduction in ionic crystals.

**Unit II - Battery Materials – Electrodes and Electrolyte**

Battery Materials *-*  Introduction – methods of synthesis – effect of particle size and morphology- natural vs cathode and anode materials.

*Electrolytes*: Liquid Electrolytes-polymeric electrolytes: Introduction –Lithium transport in lithium batteries-Polymer electrolytes in lithium batteries -various approaches towards improved properties.

**Unit III - Solid State Batteries and SEI Formation**

Solid State Batteries- Thermodynamics and Mass transport in solid state batteries -Battery performance and electrode kinetics- Double layer and other polarization effects at solid/solid interface.*SEI* Formation: Introduction -SEI formation: The main principles and routes of the SEI formation- Structure of the SEI.

**Unit IV - Electrochemical Analysis**

Cyclic voltammetry of lithium cells - Impedance spectroscopy of super ionic materials – Terminologies in charge/ Discharge analysis and cycle life measurements of various lithium based ionic materials.

**Unit V - Applications**

Fuel Cells: Introduction, operation- Types of fuel cells and applications- High temperature and Low temperature fuel cells- materials and synthesis methods - Electrochromic devices: Introduction and operation, synthesis methods of materials used in EC devices.

**Books For Study/Reference:**

1. G.A.Nazri and G.Pistoia, Lithium Batteries Science And Technology, Kluwer Academic Publishers, 2004
2. P. B.Balbuena, Y.Wang, Lithium-Ion-Batteries Solid Electrolyte Interphase**,** University of South Carolina, Imperial College Press, 2004.
3. A.L.Laskar and S.Chandra, Superionic Solids And Solid Electrolytes-Recent Trends, Academic Press 1989.
4. T.Kudo and K.Funke, Solid State Ionics, VCH Publishers, 1980.
5. S.Chandra, Super Ionic Solids-Priciples and Applications, North Holland, 1981.
6. T.Takahashi and A.Kozawa, Applications and Solid Electrolytes, JECPress, 1980.
7. C.A.C.Sequire and A. Hooper, Solid State Batteries, NATO ASI Series, Martinus Nijoff Publication, 1985.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C4**

**CORE COURSE - IV (4) – CRYSTAL GROWTH METHODS AND**

**CHARACTERIZATION TECHNIQUES**

**Unit I - Thermodynamics of Crystal Growth**

Saturation and super saturation – solubility curve – expression for super saturation –solubility diagram –nucleation – Theories of nucleation – Gibbs Thomson equation for vapour – Modified Thomson’s equation for melt – Gibbs Thomson equation for solution – Kinetic of crystal growth – Single and rough faces – Models of surface roughness - KSU theroy and BCF theory.

**Unit II - Growth from solutions**

Low temperature solution growth: Slow cooling process – solvent evaporation process – Temperature difference process – Use of electrolytic process high temperature solution growth: Solvent & solutions - slow cooling methods – temperature difference methods – high pressure method – solvent evaporation method – electrolytic process - liquid phase epitaxy.

**Unit III - Growth from melt**

Bridgeman and related techniques – crystal pulling – convection in melts – modeling and simulation of bulk crystal growth considering melt growth – czocharalski technique – zone melting technique – skull melting process – verneuil process-Heat exchange method.

**Unit IV - Other Crystal Growth Techniques**

Physical vapour deposition-chemical vapour deposition – chemical vapour transport – definition – fundamentals – choice of transport reactions – specifications – Transported materials and agents-STP,LTVTP,OTP-Hydrothermal growth:Design aspect of autoclave-electro crystallization-Gel method:principle-types of gels-structure of gels-growth in gels-experimental procedure-biological crystallization.

**Unit V - Analysis and Characterization of Crystals**

Optical transmission studies (UV) Micro hardness studies-Structural analysis-XRD-Fourier Transform-IR-Spectral analysis-Scanning Electron Microscope (SEM)-different etching techniques.

**Books for Reference:**

1. Brice J.C, Crystal Growth Processes, John Wiley & sons , New York 1986,
2. Santhanaraghavan P, Ramasamy . P, Crystal Growth – Process and Methods, KRU Publications, Kumbakonam, 2000.
3. Buckly H.E, Crystal Growth, John Wiley & Sons, New York, 1986.
4. Gilman J, The Art of Science of Growing Crystals, John Wiley & Sons, New York, 1956.
5. William Kemp, Oraganic spectroscopy, 3rd Edition, , Palgrave, New York, 2004.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C5**

**CORE COURSE - IV (5) – PRINCIPLES OF NANOMATERIALS AND TECHNOLOGY**

**Unit I - Fundamentals of Nanoscience**

Scientific Revolutions – Types of Nanotechnology and Nanomachines- the periodic table – Atomic structure – molecules and phases – Energy – Molecular and atomic size – Surface and dimensional space – top down and bottom – Forces – Electrostatic and Vander Waals forces between surfaces – similarities and differences between intermolecular and inter particle forces – Covalend and coulomb interactions – polar molecules – Thermodynamics of self assembly.

**Unit II - Synthesis of Nanomaterials**

Film deposition methods : Fundamentals of film deposition – Spray Pyrolysis, molecular beam epitaxy – pulsed laser deposition – chemical vapour deposition – layer by layer growth and ultra thin films. Sol - gel methods : Fundamentals of sol – gel process- sol-gel, Synthesis methods for oxides – other inorganics and nano composites – the pecheni method – silica gel – zirconia and Yttrium gel- alumina silicate gel – polymer nano composites.

**Unit III - Preparation Techniques**

Ball milling- laser abalation- molecular beam epitaxy- sputtering- chemical route - sol-gel process- sol - gel synthesis methods for oxides- other inorganics and nano composites-hydrothermal – solvothermal.

**Unit IV - Photonic Devices**

Metal semiconductor contacts Space charge region Schooty effect Ohmic Contact Basic Microwave technology Tunnel Diode Impatt diodes Transferred electron devices Quantum effect devices Light emitting diodes Basics of Solar Cells Lasers and Quantum well Lasers.

**Unit V - Applications of Nanomaterials**

Nanotechnology in industries Quantum computations Super computing system Drug delivery system Drug encapsulation Magnetic Data Storage Magnetic Semiconductors Spintronics devices Nanosensors Optical industry metrology Defence and environment.

**Books for Reference:**

1. C.Cao,Nanostructures and Nanomaterials Synthesis, Properties and Applications,Imperial College Press, 2004.
2. Daniel L.Feldheim Colby,A.Foss,Metal Nanoparticles,Synthesis,Characterization and Applications,Wiley VCH ,1998.
3. Dider A, Nanoparticles and Catalysis, Wiley VCH, 2008.
4. G.C.Hdjipanayis,R.W.Seigal Nanophase Materials,Properties and Applications, Kluwer Academic Publishers 1994.
5. Skoog.D.A,James,Holler.F.Neiman.T.A. Principles and Instrumental Analysis,Harcourt College Press, 2007.
6. P.N.Prasad Nanophotonics,Wiley Intersciences, 2004.

♣♣♣♣♣♣♣♣♣♣

**I YEAR - II SEMESTER**

**COURSE CODE: 7PPH2C6**

**CORE COURSE – IV (6) – BIOPHYSICS AND BIOMATERIALS**

**Unit I - Biomolecular Structure**

Role and importance of structural biophysics. Levels of molecular organization in the cell. Understanding structures of proteins at primary, secondary, tertiary, quaternary and macromolecular assembly levels. Conformational analysis and forces that keep them together. Ramachandran map and its applications in protein structure validation. Understanding structures of nucleic acids at primary, secondary, tertiary and quaternary level. Analysis of protein - protein and protein - nucleic acid interactions. Polysaccharides. Lipids and membrane proteins in biological membranes.

**Unit II - X-Ray and NMR**

Scope and applications of biophysical methods: CD/ORD, Dynamic Light Scattering (DLS), Fluorescence Spectroscopy, Raman Spectroscopy, Cryo-Electron Microscopy, Single Particle Cryo-Electron Microscopy, Nuclear Magnetic Resonance (NMR), X-ray crystallography. Understanding structure, function and dynamics of macromolecules with specific examples (proteins and their complexes-ribosome, proteasome) using these methods. Protein folding and unfolding.

**Unit III - Spectrometer and Chromatography**

Theory and applications of: Colorimeter, UV-Vis spectrophotometer, centrifugation, principle and applications of analytical ultracentrifugation, pH meter & buffers, Methods of protein estimation (Lowry and Bradford), DNA/RNA estimation and thin layer chromatography.

**Unit IV - Biophysics Application**

Database in proteins, Sequence database, Structural database, sequence comparison methods Nucleic acid database, Human genome mapping project, carbohydrate database. Enzyme database and analysis. Protein structure prediction. Gene prediction. Molecular modeling and drug designing.

**Unit V - Molecular Thermodynamics**

Equilibrium thermodynamics – near equilibrium thermodynamics - Gibbs free energy – chemical potential – thermodynamic analysis of membrane transport – phase equilibrium – irreversible thermodynamics. Molecular mechanism of genetic information transfer Genetic code – transmission of genetic information – molecular mechanism of Protein synthesis-transcription – translation – recognition of Amino acids – Protein Biosynthesis-principle of molecular recognition – intercellular interaction.

**Books for Reference:**

1. Gregory A. Petsko, Dagmar Ringe, Protein structure and Function - New Science Press, 2004.
2. Vasantha Pattabhi, N. Gautham ,Biophysics, Alpha Science International Limited, 2002.
3. Donald Voet, Judith G. Voet, Charlotte W. Pratt. Fundamentals of Biochemistry: Life at the Molecular Level, Wiley, 2012.
4. Rodney M. J. Cotterill , Biophysics - An Introduction , John Wiley, Publication, 2002.
5. Holand Glacer, Biophysics, Pringer Publications, 3rd Edition, 2000.
6. P. K. Srivastava Elementary Biophysics, An Introduction, Narosa Publishing House, 2nd Edition, 2011.

♣♣♣♣♣♣♣♣♣♣