CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT, ODISHA

SCHOOL OF BASIC SCIENCES

2-YEAR M.Sc. PROGRAMME

IN

Applied Physics (Material Science Stream)

M.Sc. Applied Physics (3rd and 4th Semester courses)
(for Stream-II: Material Sciences)

SEMESTER-III				
Sl no	**Subject Code**	**Subject**	**Contact Hours per week (L+T+P)**	**Credits**
1	MSPH5106	Solid State Physics-II	3+1+0	4
	MSPH5107	Physics of Soft Materials-I	3+1+0	4
3	MSPH5108	Introduction to Biomaterials	3+1+0	4
4	MSPH5109	Synthesis & Characterization of Soft Materials	3+1+0	4
5	MSPH5110	Introduction to Research	2+0+0	2
6	MSPL5103	Physics of Materials Lab-II	0+0+3	2
7	MSPJ5102	MINOR PROJECT /DISSERTATION	As per requirement	4
TOTAL CREDITS				24

SEMESTER-IV				
Sl no	**Subject Code**	**Subject**	**Contact Hours per week (L+T+P)**	**Credits**
1	MSPH5204	Physics of Soft Materials-II	3+1+0	4
2	MSPH5205	Physics of Materials-II	3+1+0	4
3	MSPH5206	Introduction to Nonmaterial	3+1+0	4
4	MSPL5202	Physics of Materials Lab-III	0+0+3	2
5	MSSM5202	Seminar	As per requirement	2
6	MSPJ5202	MAJOR PROJECT/ DISSERTATION	As per requirement	8
TOTAL CREDITS				24

Solid State Physics II

(4 credits)

Module-1: (18 hours)

Crystalline state, crystal structure, Mechanical properties: Classical and quantum theory of harmonic crystal, phonons in metals, phonon dispersion, anharmonic effects.

Metals: Drude theory – model, dc electrical conductivity, hall effect, thermal conductivity, failures Sommerfeld theory – model, ground state properties of electron gas, Fermi Dirac distribution, Thermal conductivity, failure of free electron theory

Energy Bands in solids: Nearly free electron model, origin of energy gap, Bloch theorem and review of KronigPenny model (detailed derivation not required), band theory, Metal, insulators and semiconductors. Tight binding method

Module-2: (18 hours)

Insulators: Dielectric properties, theory of the local field, Clausius-Mossotti relation, theory of polarizability, optical properties of ionic crystals, pyroelectric and ferroelectric crystals.

Semiconductors: Band gap, instrinsic semiconductors (Si and Ge), intrinsic mobility, effective masses,

doping and extrinsic semiconductors, impurity conductivity.

Module-3: (20 hours)

Magentic properties, Van-Vleck and Pauli paramagnetism, Curie's law, Larmor and Landau diamagnetism, Ferromagnetism and antiferromagnetism (comparative description), magnetic resonance.

Superconductivity : Superconductivity, thermodynamics of superconducting transition, London equation, BCS theory, Dc and Ac Josephson's effect.

Suggested textbook:

1. Introduction to Solid State Physics, C. Kittel, Wiley, 2012.

Reference Book:

1. Solid State Physics, by N. W. Ashcroft and N. D. Mermin (Cornell University), 2003.
2. Introduction to Solid State Physics,S. O. Pillai, New Age International (2005)

Physics of Soft Materials-I

Semester III (Credit 4)

Module-I (16 lectures)

What is soft matter? : Polymers, Colloids, Surfactants, Liquid crystals, what is common in soft matter?

Soft matter solutions: Thermodynamics of solutions, Phase separation, Lattice model, Polymer solutions, Colloidal solutions, Multi-component solutions

Module-II (22 lectures)

Elastic soft matter: Elastic soft matter, Elasticity of a polymer chain, Polymer gels

Surface and surfactants: Surface tension, wetting, surfactants, Inter-surface potential

Module-III (14 lectures)

Liquid crystals: Nematic liquid crystals, Mean field theory for the isotropic - nematic transition, Landau-de Gennes theory, Onsager's theory for the isotropic- nematic transition of rod like

Text Book:

1. Soft Matter Physics by Masao Doi, Oxford University Press

Reference Books:

2. Soft Materials: Structure and Dynamics, John R. Dutcher, Alejandro G. Marangoni
3. Fundamentals of Soft Matter Science by Linda S. Hirst,CRC Press J Taylor &Francis Group
4. Principles of Condensed Matter Physics – P.M. Chaikin and T.C. Lubensky.

Introduction to biomaterials

Semester III (Credit 4)

Module I [16 hours
Introduction: Types of bonds in materials, Ionic bond, metallic bond, covalent bond,secondary bond. Different types of materials – Ceramic, metals, polymers and composites.Impact of biomaterials.**[6 hrs**

Basic properties of materials: Mechanical properties – tensile testing, compressive testing, shear testing, bend or flexural tests, viscoelastic behavior, ductile and brittle fracture, stress concentration, fracture toughness, fatigue.
Electrochemical properties – Corrosion, types of corrosion
Surface properties – Contact angle, hardness **[10 hrs**

Module II [17 hours

Biological systems: The biological environment, genetic regulation and control systems, the plasma membrane, Cytoskeleton and motility, Cell to cell communication pathways, Cell junctions – tight junctions, gap junctions, adherens and desmosomes, Cell signaling pathways – Receptors as signaling sensors, receptor classes, second messenger and their activation/deactivation. **[10 hrs**

Characterization of biomaterials (Part I): Contact angle, infrared spectroscopy, X-ray photoelectron spectroscopy, secondary ion mass spectroscopy. **[7 hours**

Module III [18 hours

Characterization of biomaterials (Part II): Atomic force microscopy, scanning electon microscopy, transmission electron microscopy, XRD, chromatography – high-performance liquid chromatography, gel permeation chromatography. **[7 hrs**

Natural biomaterials: Collagen, elastin, silk, chitosan, cellulose, alginate, hyaluronan, chondroitin sulfate, coral.**[11 hrs**

Books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications (Cambridge Texts in Biomedical Engineering) 1st Edition, by C. Mauli Agrawal, Joo L Ong, Mark R. Appleford, Gopinath Mani
2. An Introduction to Biomaterials, Second Edition, Jeffrey O. Hollinger
3. Biomaterials, An introduction, Joon Park, R S Lakes

Synthesis & Characterization of Soft Materials
Semester III (Credit 4) (Theory+Practice)

Module- I (18 hours)
Colloidal Materials:
Introduction, classification of Colloidal Systems, Synthesis of Colloids: Dispersion methods, Aggregation methods, Characteristics of colloids, Competing Forces in Colloidal Dispersions, Interparticle Interactions: van derWaals Attraction, Electrostatic Forces, DLVO Theory, Depletion Forces, Steric Repulsion,

Experimental Techniques: Light Scattering (Dynamic Light Scattering, Static Light Scattering), Zeta Potential and the Electric Double Layer, Rheology Measurements,

Module-II (20 hours)

Polymers:

Introduction; Early Polymers, Polymer Structure, characteristics, and synthesis (mechanism is excluded),Experimental Techniques: Scattering technique, FTIR, Raman spectroscopy, NMR

Liquid Crystal:

Introduction to Liquid Crystals, Experimental Techniques: Deforming Liquid Crystals, Polarized Optical Microscopy, X-ray Diffraction, Differential Scanning Calorimetry, Electro-optical Measurements, Applications of Liquid Crystals

Module III (16 hours)

Gels:

Introduction, Composition, types of Gels: Hydrogels, Organ gels, xerogels, and nanocomposite hydrogels, properties; **Hydrogels**: Classification of hydrogel, Synthesis of hydrogels, Hydrogel Properties, Application: Hydrogels in Pharmaceutical Applications, Hydrogels in electronics Applications. Applications of hydrogels in wound healing, Applications of hydrogels in tissue engineering,

Reference Book:

Fundamentals of Soft Matter Science By*Linda S. Hirst,* CRC Press J Taylor &Francis Group

Practice: Any 5 experiments to be done

Colloidal State:

1. To prepare colloidal solutions of arsenic sulphide, antimony sulphide, cadmium sulphide, sulphur, ferric hydroxide, silver, and gelatine
2. To study the protective action of hydrophilic colloid on the precipitation of hydrophobic colloid
3. To study the mutual coagulation of As_2S_3 sol. And $Fe(OH)_3$ sol and determine the optimum ratio for precipitation
4. To study the coagulation of As_2S_3 sol with NaCl, $BaCl_2$, and $AlCl_3$ and hence find their coagulating values
5. Determine the nature of the charge carried by particles in a given sol, and measure their electrophoretic mobility and zeta potential of the sol.
6. Preparation of four liquid crystal sheets and testing in water bath
7. Fabrication of liquid crystal room thermometer

Course Code: MSRM5101

Course Title: INTRODUCTION TO RESEARCH

Credit: 2

Paper Type: Theory

Course Objectives:

To introduce the students to the concept, methods, techniques and the processes of research.

Course outcome:

1. Students will be able to understand the process of doing a research.
2. Students will be able to carry out the process under supervision and prepare research reports.

Course Contents:

Module-I: (13)

Research: Introductory Concepts

Curiosity and Research, Common sense vs. Sciences, Role of Observation and Scientific Methods, Experiments as the basis of Sciences, Various types of Research Methods in Sciences, Discussion of various research methods.

Overview of Research Process: (7)

Problem Definition, Proposition of Hypotheses, Hypothesis Testing, Types of Possible Errors in Hypothesis Testing, Proposition of Models and Theories, Literature Review, Experimental Design, Sampling and Survey, Measurement of Values and Dealing with Errors, Validation of Results, Improving Theories, Models and Experiments, Safety and Ethics.

Module-II: (12)

Data Analysis-I: Use of Statistics in Data Analysis, Probability Distributions, Central Limit Theorem and its applications in Data Analysis, Comparing many experimental measurements, Data with many values of independent variables.

Data Analysis-II: Building Mathematical Models, Ingredients of Mathematical Models, Estimation, Regression methods, Fourier Transforms, Interative Maps, Differential Equations.

Other Methods of Data Analysis: Tables, Graphs and Charts.

Module: III (5)

Documentation and Presentation:

Scientific Proposal Writing, Scientific Report Writing, Parts of a Scientific Report, Presentations, Ethical Issues in Report Writing.

Books Recommended:

1. Michael P Marder, 2011, Research Methods for Science, Cambridge University Press.
2. Eugene Bright Wilson, 1991, An Introduction to Scientific Research, Dover Publications Inc.
3. Ranjit Kumar, 2011, Research Methodology: A Step by Step Guide, Sage South Asia Publication.

Physics of Materials II Lab

(Credit 2)

Experiments List

1. *To study the properties and behaviour of Langmuir films of selected compounds using Langmuir-*Blodget.
2. Rheology:rheometer - experiment.
3. Study of Newtonian fluids.
4. Study of Non Newtonian fluids: shear thinning/shear thickening
5. Study of visco-elastic fluids
6. Couette taylor flow experiment
7. To determine the velocity of sound in air.
8. Experimental study of Faraday instability
9. Derive equation of state for hard sphere collodial suspension using sedimentation profile.
10. Preparation of colloidal samples at different concentrations and characterizing their phase behavior (fluid,fluid-crystal coexistence,crystalline and glassy state) by visual observation and optical bright field microscope.
11. Temperature dependent viscosity of Newtonian fluid using capillary viscometer.
12. Temperature induced melting and freezing of thermo-responsive colloids.