

Chemistry Department
Kumaun University, Nainital
Pre-Ph.D. Course work

Chemistry Paper-II

NOTE:

- i) The syllabus of Pre-Ph.D. Course work Chemistry Paper-II has two sections, **Section-A** and **Section-B**.
- ii) Candidates are advised to opt for one section depending upon which course contents are useful for their further Ph. D. program.
- iii) The question paper will be one only and there will be questions from both the sections with internal choice.
- iv) Candidates are advised to attempt questions either from Natural Products Chemistry or from Nanoscience & Nanotechnology.

Section -A

Nanoscience & Nanotechnology

1. Basics and Classification of Nanomaterials: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, Classifications and types of nanomaterials as nano particles and 1D 2D 3D nanomaterials, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.
2. Methods of Synthesis Nanomaterials: Top-down and down-up approach for synthesis of nanomaterials, Nucleation and growth of nano systems; self assembly, mechanical milling, laser ablation, sputtering and microwave plasma, chemical reduction and oxidation, hydrothermal, micelles, sol-gel processes.
3. Advanced Characterization techniques of nanomaterials: Scanning Electron Microscopy (SEM and FESEM), Transmission Electron Microscopy (TEM) approach, High resolution Transmission Electron Microscopy (HRTEM), Atomic Force Microscopy (AFM), X-ray powder diffraction, X-Ray Photoelectron Spectroscopy, Raman spectroscopy.
4. Application of Nanomaterials: Applications of nanomaterials in electronics, biological and environmental, Energy conservation and storage, water purification, Nanotechnology in Food industry and Agriculture.

Recommended Books:

1. Introductory Nanoscience, by Masuro Kuno, Garland Science 2011.
2. Introduction to Nanotechnology, by Poole and Owen, Wiley Indian Edition 2010.

3. Nanophysics and Nanotechnology, by Edward L. Wolf, Wiley-VCH (2006).
4. Chemistry of nanomaterials: Synthesis, properties and applications, by C.N.R. Rao. Wiley-VCH Verlag GmbH & Co. KGaA, 2004.
5. Nanoparticles: From theory to applications, by G. Schmidt, Wiley Weinheim 2004.
6. Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, by Ghuzang G.Cao, 2004
7. Hand Book of Nanophase & Nanostructured materials (Vol. I&II), by Zhong Lin Wang, Springer, 2002.

Section-B

Natural Products Chemistry

1. **Introduction:** Natural Products: Primary and Secondary metabolites, use of natural products in traditional medicine, potential of natural products, natural products in drug discovery and development.
2. **Chemistry of natural products:** Introduction, occurrence, classification, extraction, isolation, separation, purification, synthesis, and biosynthesis of alkaloids, flavonoids, phenolics, saponins, steroids, and terpenoids.
3. **Extraction and separation methods** Maceration, percolation, reflux extraction, Soxhlet extraction, liquid-liquid extraction, counter-current extraction, supercritical fluid extraction, ultrasound and microwave assisted extraction, pulsed electric field and enzyme assisted extraction. Theory and techniques of distillation, fractional distillation, steam distillation, vacuum distillation, theory of action of drying agents, fractionation by evaporation, working of rotary film evaporator and crystallization.
4. **Chromatographic Techniques:** Principle and applications of adsorption (TLC, paper chromatography, column chromatography, gas chromatography, HPTLC, HPLC, Gel permeation chromatography, flash chromatography and super critical fluid chromatography, ion-exchange chromatography) with suitable example and chromatogram. Extraction-distribution law. Preparative GC. Multi-dimensional chromatographic separation (3D Prep GC, TWO-3D Prep GC)
5. **Analytical Techniques:** Introduction, principle, instrumentation and applications with reference to UV-visible, FT-IR, ATR, Non-linear 2D IR, Raman spectroscopy and FT Raman scattering, ¹H-NMR and FT-NMR, ¹³C-NMR, 2D-NMR [COSY (HETCOR, HOMCOR), DEPT, INADEQUATE, NOE, NOSY, HMBC, HMQC, EXSY, TOCSY]. Principle and application of GC-FT-IR, GC-MS, LC-MS, ESI-MS, Peptide mass fingerprinting (PMF)-MS, LC-NMR.

X-Ray Crystallography: Theory, principle, and applications, powder diffraction, small angle X-ray fibre diffraction (SAXS), X-ray fibre diffraction.

Prof. Anand B. Melkani
 Convener, Chemistry
 Kumaun University, Nainital