Syllabus for Scientific Assistant (Instruments)-Bioceramics VOP

I. Analytical Chemistry

Basic Concepts of atoms and atomic structure; Mole, molar mass; Calculations in grams and moles; Solutions and their concentrations: Molar concentration, Analytical molarity, Equilibrium molarity of a particular species, Percent concentration, Parts per million/billion (ppm, ppb); Preparing standard solutions and the primary and secondary standards.

Accuracy and precision, absolute and relative uncertainty and propagation of uncertainty.

Statistical tests of data (the F test, the t test, Q test for bad data, the method of least squares). Relevance of Calibration curve.

II. Analytical Instrumentation

Colorimetry and Spectrophotometry: Molecular energy levels, types of molecular transitions, Lambert-Beers Law, types of sources, monochromators and detectors, single beam and double beam layout.

Infrared Spectroscopy: Diatomic molecules as a simple harmonic oscillator, Instrumentation of IR Spectrometer, sample handling. Fourier Transform Infrared Spectroscopy (FTIR) - Interpretation of Infrared (IR) spectra.

Atomic Spectroscopy: Atomic transitions, atomic absorption and emission, atomisation process, types of flames, instrumentation of optical spectrophotometers. Flame photometer, Principles and instrumentation of Atomic absorption spectroscopy (AAS) and Atomic emission spectroscopy (AES), analysis methods and their biomedical applications.

Separation methods: Theory of chromatography; instrumentation and applications of Paper chromatography, Thin layer chromatography (TLC);

Principle, instrumentation and applications of Column chromatography, Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC); Mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, details of detectors.

III. Essentials of Materials Science

Structure and Properties of materials.

Structure of Crystals - Ideas on lattice, Miller indices, Crystal structures, Polymorphism & Polytypism. Packing of crystals. Solid Solutions.

Structural Imperfections - Point Defects -- Frenkel & Schottky defects. Line defects - Edge & Screw dislocations. Grain boundaries. Twining and Stacking faults in crystals.

Elements of X ray Diffraction. Bragg's Law. Instrumentation of data interpretation of XRD.

Mechanical Properties of materials – Stress-Strain behaviours . Universal Testing Machine.

Corrosion, Dissolution and Resorption - Galvanic theory, Electrochemical corrosion, Rate, Types, Corrosion prevention methods. Biological resorption in vivo.

Basics of polymer materials - Elementary structural features and properties, Formation of various polymers, Polyethylene and Rubber, Glass transition temperature, Thermoplasts and thermosets.

Definition and Classification of Biomaterials

IVa. Ceramics processing

Principles of diffusion and mass transfer between Phases; Chemical Composition and Phase compositions; Particle size and shapes; Density, pore structure and specific surface area; Rheological behaviour of slurries and pastes.

Comminution ; Batching and mixing; Granulation. Ceramic forming processes: Dry pressing; Plastic forming; Slip Casting; Drying; Shaping, and surface finishing. Sintering : Furnaces, temperature measurements, Pre sintering processes, sintering steps.

Processing of bioceramic materials, chemical synthesis of inorganic biocompatible materials, spray drying, making green bodies and optimising sintering steps.

IVb. Ceramics characterization

Instrumentation and data interpretation of Dilatometric analysis ; Differential Thermal Analysis, Thermo Gravimetric Analysis, Particle size distribution.

Phase analysis using XRD and FTIR; Analysis of microstructure using Optical and electron Microscopy.

Mechanical Tests - Tensile test, Compression test, Hardness test, Impact test, Fatigue test.

References

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4. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers, 7th edition, 1988.
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7. Hand book of Instrumental Techniques for Analytical Chemistry,Prentice Hall, 1997.
8. *WF Smith, Principles of Materials Science and Engineering, 2nd Edition Mc Grawhill, 1995.*
9. *WD Kingery, Introduction to Ceramics, 2nd Edition Wiley, 2016*
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