Syllabus for Paper III (core)
Post code : CST
Taken from curriculum of first degree program –Physics/Chemistry (Kerala university -2018 revised) (B1530102357.pdf & BSc-Chemistrys1498633096.pdf)

Physics:

Circuit Theory:

Ohm's Law, Kirchhoff's law- Ideal voltage and current sources- Thevenin's and Norton's theorem, Maximum power transfer theorem

Modulation:

Fundamentals of modulation - AM, FM - frequency spectrum of AM - power in AM - demodulation of AM signal - frequency spectrum for FM

Diode circuits:

Extrinsic semiconductors-n- type and – p-type semiconductors, Diodes-PN junction diode-PN junction under forward and reverse biased conditions-r m s value and peak inverse voltage- diode characteristics-ac and dc resistances- half wave and full wave rectifiers- (average dc value of current, ripple factor and efficiency)- different types of filters (shunt capacitor, LC and RC)- break down mechanism in diodes- Zener diode-voltage regulator

Power amplifiers:

Amplifier classes and efficiency - class A operation - transformer coupled class A amplifier - class B amplifier - push pull amplifier - basic ideas of class C operation - distortion in amplifiers, Operational amplifiers.

Atomic Spectra :

Optical spectra-Spectral terms and notations - selection rules - intensity rule and interval rule - fine structure of sodium D lines – hyperfine structure-alkali spectra - Zeeman effect - Larmor's theorem – quantum mechanical explanation of normal Zeeman effect. Anomalous Zeeman effect –Paschen-Back effect-Stark effect.

Electromagnetic spectra: Molecular energies-classification of molecules-rotational spectra of diatomic molecules-rotational energy levels-selection rules-rotational spectrum-isotope effect- bond length and atomic mass. Diatomic vibrational spectra-vibrational energy levels-selection rule-vibrational transitions-Rotation-Vibration transitions-IR spectrometer Raman scattering- classical description of Raman scattering, quantum theory of Raman scattering- -vibrational Raman spectra-diatomic molecules-polyatomic molecules-rotational Raman spectra Raman spectrometer. Electronic spectra sequences and progressions-Frank-Condon principle

Resonance Spectroscopy:

NMR principle-Resonance condition-NMR spectrometer-chemical shift-indirect spin-spinInteraction- applications of NMR spectroscopyESR principle- Resonance condition – ESR spectrometer-hyperfine interaction – applications of ESR spectroscopy. Mossbauer spectroscopy- principle -isomer shift.

X-ray Diffraction:

X-rays- Discovery- properties -scattering -Measurement of X-ray wavelengths by ruled gratings-X-ray Spectra- continuous and characteristics X- ray spectrum-Origin of continuous Spectrum -Origin of characteristic X-rays-X-ray energy level diagram. -Absorption of X-rays-Applications of X-rays

Lasers:

Introduction-Interaction of light with matter, Absorption, spontaneous emission, stimulated emission, Light amplification, population inversion, metastable states Components of Laser-Principal pumping Schemes-Role of resonant cavity- Ruby laser, He-Ne Laser-Applications.

Interference of light:

The principle of superposition - coherent sources – Double slit interference (theory of interference fringes and band width) - Interference by division of wave front and amplitude –Fresnel's biprism-interference in thin filmsclassification of fringes-wedge shaped films-testing of optical flatnessNewton's rings(reflected system)-refractive index of a liquidMichelson interferometer – determination of wavelength

Nanotechnology:

Length scales in Physics- nanometre- Nanostructures: Zero, One Two and Three dimensional nanostructures Band Structure and Desnsity of State at nanoscale: Energy Bands, Density of States at low dimensional structures.

Characterization of nanomaterials:

Atomic Structures -Grain size determination – XRD (Debye Scherrer equation), Microscopy – Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM), Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM)

Chemistry:

Atomic Structure and Periodicity:

Introduction to the structure of atom - Dual nature of electron - de Broglie equation - matter waves and electromagnetic waves - Heisenberg's uncertainty principle - expression and significance. Wave mechanical concept of the atom - Schrodinger equation (Derivation not required) - Quantum numbers - Pauli's exclusion Principle - Aufbau Principle – Hund's rule - Electronic configuration of atoms - classification of elements into s, p, d, f blocks - electronegativity- Pauling's scale, Mulliken and Allred - Rochow scale

Chemistry of Nanomaterials:

Evolution of Nanoscience – Historical aspects- Preparations containing nano gold in traditional medicine. Lycurgus cup- Faraday's divided metal etc. Nanosystems in nature. Preparation of nanoparticles: Top-down approaches and Bottom to top approach Sol–gel synthesis, Colloidal precipitation, Co–precipitation, Combustion technique, Sonochemistry, Hydrothermal technique, High energy ball milling etc. Carbon nanotubes and fullerenes. Properties of nanoparticles: optical, magnetic, mechanical, thermal and catalytic properties with examples.

Analytical Principles:

Inorganic qualitative analysis - Common ion effect - solubility product - precipitation of cations. Microscale analysis – Advantages Quantitative Analysis - Theory of titration - acid-base, redox, precipitation and complexometric titrations. Theory of indicators - acid-base, redox, adsorption and metallochromic indicators. Chromatography - Classification of methods - Elementary study of adsorption chromatography. Column and thin layer-partition chromatography-paper- ion exchange and gas chromatographic methods.

Instrumental Methods of Analysis:

Atomic absorption spectroscopy- flame emission spectroscopy- applications – colorimetry spectrophotometry- laws of spectrophotometry- Beer- Lambert's law-applications of spectro photometry thermal methods- introduction to TG, DTA and DSC-instrumentations and applications. Tools for measuring nanostructures: XRD, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy(STM), Scanning Electron Microscopy(SEM), Transmission Electron Microscopy(TEM)

Organic Spectroscopy:

UV – Visible spectroscopy – types of electronic transitions, effect of conjugation, concept of chromophore, auxochrome, bathochromic, hypochromic shifts, hyperchromic and hypochromic effects. UV-Visible spectra of enes. Calculation of λmax of dienes and α,β-unsaturated ketones. IR spectroscopy – Molecular vibrations - Functional group and finger print region – group frequencies – effect of hydrogen bonding on –OH stretching frequency – factors influencing carbonyl stretching frequency. Comparison of carbonyl stretching frequency in compounds containing carbonyl group. Interpretation of IR spectra of simple organic molecules such as salicylaldehyde, benzamide, acetophenone, nitro benzoic acid and phenyl acetate.

Theory of Mass spectrometry – mass spectrum, base peak and molecular ion peak, types of fragmentation, McLafferty rearrangement, isotopic effect. NMR spectroscopy – principle of proton NMR – shielding and deshielding effect, chemical shift, factors influencing chemical shift, spin-spin splitting, coupling constant, interpretation of PMR

spectrum of simple molecules like CHBr2CH2Br, ethylbromide, pure ethanol and impure ethanol (acidic impurities) acetaldehyde and toluene. Structural elucidation of simple organic molecules using IR and NMR spectroscopic techniques.

Spectroscopy :

Regions of electromagnetic spectrum. Different units of energy (erg, joule, calorie, cm-1, Hz, A0 and eV) and their inter conversions. Interaction of radiations with matter. Various types of molecular spectra. Born-Oppenheimer approximation. Rotational spectroscopy: microwave spectra of diatomic molecules, energy expression, selection rule, rotational energy levels, determination of bond length. Vibrational spectroscopy: Harmonic oscillator. IR spectra of diatomic molecules. Energy expression. Selection rules, frequency of separation, calculation of force constant, anharmonic oscillators. Morse equation. Fundamental and overtone transitions, combination bands, degree of freedom of polyatomic molecules. Raman spectroscopy: Stoke's and antistoke's lines and their intensity difference, rotational Raman spectrum. Selection rule. Frequency of separation, vibrational Raman spectrum, Mutual exclusion principle.

Electronic spectroscopy: Frank-Condon principle. Singlet and triplet states. Electronic spectra and diatomic molecules. Dissociation energy, electronic spectra of polyatomic molecules (qualitative idea only). NMR spectroscopy: Principle of NMR, nuclear spin. Interaction of nuclear spin with external magnet. Precession. Relaxation, Chemical shift. Low resolution spectra. Delta and tau scales. Spin-spin coupling and high resolution spectra, Electron spin resonance spectroscopy: principle. Types of substances with unpaired electrons, interaction of electron magnet with external magnet. Energy level spliting. Lande splitting factor, Introduction to Mossbauer Spectroscopy

Non-spectroscopic methods:

Dipole moment, Debye equation and Clausius-Mosotti equation, measurement of dipole moment by temperature method, Dipole moment and molecular structure, iamagnetism and paramagnetism, Magnetic susceptibility and unpaired electrons, measurement of magnetic susceptibility, Molar refraction and molecular structure, Atomic refraction, Optical exaltation, Parachor and atomic equivalent of para chor.