SANJIVANI UNIVERSITY

(Estt. under Government of Maharashtra Act No. XX of 2024)
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Syllabus for Ph.D. (PET) Entrance Exam
Paper 2: Programme Specific (Interdisciplinary Studies)

A. Chemistry:

1. **Inorganic Chemistry**

Chemical periodicity, Chemical bonding (VSEPR Theory, MO Theory), Acids and bases (Hard-Soft acid base concept), Atomic structure (Bohr's theory, quantum numbers), Nuclear chemistry (nuclear reactions, fission and fusion), Main group elements and their compounds, Transition elements and coordination compounds Organometallic compounds, Bioinorganic chemistry, Characterization techniques (IR, Raman, NMR, EPR, Mössbauer, UV-vis, MS)

2. **Organic Chemistry**

IUPAC nomenclature, Stereochemistry (configurational and conformational isomerism), Aromaticity, Organic reactive intermediates, Organic reaction mechanisms (addition, elimination, substitution, Named reactions and rearrangements, Organic transformations and reagents, Concepts in organic synthesis (retrosynthesis, disconnection), Asymmetric synthesis

3. **Physical Chemistry**

Thermodynamics (laws, thermodynamic potentials), Chemical kinetics (rate laws, reaction mechanisms), Quantum chemistry (Schrödinger equation, quantum states), Statistical mechanics, Spectroscopy (IR, UV-vis, NMR, EPR)

4. **Analytical Chemistry**

Separation techniques (chromatography, electrophoresis), Spectroscopic methods (UV-vis, IR, NMR, MS), Electroanalytical methods (potentiometry, voltammetry), Thermal analysis (TGA, DSC)

References:

- Housecroft, C. E., & Sharpe, A. G. (2018). *Inorganic Chemistry* (5th ed.). Pearson.
- Clayden, J., Greeves, N., & Warren, S. (2012). *Organic Chemistry* (2nd ed.). Oxford University Press.
- Bruice, P. Y. (2016). *Organic Chemistry* (8th ed.). Pearson.
- Atkins, P., De Paula, J., & Keeler, J. (2017). *Atkins' Physical Chemistry* (11th ed.). Oxford University Press.
- McQuarrie, D. A., & Simon, J. D. (1997). *Physical Chemistry: A Molecular Approach*. University Science Books.
- Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.

B. Physics:

1. **Classical Mechanics**
   Newton's laws; Phase space dynamics; Central-force motion; Collision and scattering; Classical mechanics of system of particles; Rigid body dynamics, moment of inertia tensor, non-inertial frames and pseudoforces; Variational principle, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations; Symmetry, invariance and conservation laws, cyclic coordinates; Periodic motion, small oscillations and normal modes; Wave equation, phase velocity and group velocity,
2. **Electromagnetism**
   Electrostatics: Gauss' Law and its applications; Laplace and Poisson equations, boundary value problems, multiple expansion; Magnetostatics: Biot-Savart law, Ampere's theorem, electromagnetic induction; Maxwell's equations in free space and linear isotropic media; boundary conditions on fields at interfaces; Scalar and vector potentials; Gauge invariance; Electromagnetic waves in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interference, coherence
3. **Quantum Mechanics**
   Wave-particle duality; Wave functions in coordinate and momentum representations. Commutators and Heisenberg's uncertainty principle; Schroedinger equation; Particle moving in a one-dimensional potential; Tunnelling through a barrier; Motion in a central potential, symmetry, conservation laws and degeneracy; Orbital angular momentum, Angular momentum algebra, spin; Addition of angular momenta; Dirac's bra and ket notation; Matrix representation; Hydrogen atom, spin-orbit coupling, fine structure;
4. **Thermodynamics and Statistical Mechanics**
   Laws of thermodynamics and their consequences; Thermodynamic potentials, Maxwell relations; Chemical potential, phase equilibria; Phase space, micro- and macrostates; Microcanonical, canonical and grand-canonical ensembles and partition functions; Free Energy and connection with thermodynamic quantities; paramagnetism due to localized moments; Thermodynamics of interacting systems, Van der Wall gas, Ising model; Classical and quantum statistics; ideal Bose gases, Bose-Einstein statistics, Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation;
5. **Mathematical Methods in Physics**
   Elementary probability theory, random variables, binomial, Poisson and normal distributions; Vector algebra and vector calculus; Linear algebra, matrices; Linear differential equations; Special functions; Fourier series, Fourier and Laplace transforms; Elements of complex analysis: Laurent series-poles, residues and evaluation of integrals; Elementary ideas about tensors
6. **Electronics:**
   Semiconductor, P-N diode and characteristics, PNP and NPN transistors, Optoelectronic devices, including solar cells, photodetectors, LED, Digital techniques and applications (registers, counters, comparators and similar circuits); A/D and D/A converters; Microprocessor and microcontroller basics.

7. **Atomic & Molecular Physics**
   Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen atom; and alkali atoms Relativistic corrections for energy levels of hydrogen; Hyperfine structure, selection rules; width of spectral lines; LS & JJ coupling, Hund's rule; Mechanism of line broadening, Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Principle of resonance spectroscopy, Electron spin resonance, Nuclear magnetic resonance, chemical shift; Molecular physics, rotational, vibrational, electronic, and Raman spectra of diatomic molecules
8. **Condensed Matter Physics**
   Bravais lattices; Reciprocal lattice, diffraction and the structure factor; Defects and dislocations; Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order, Quasicrystals and glasses. Bonding of solids; Elastic properties, phonons, lattice specific heat; Free electron theory, electronic specific heat, Pauli paramagnetic susceptibility; Response and relaxation phenomena; Drude model; Hall effect and thermoelectric power; Electron motion in a periodic potential, band theory of metals, insulators and semiconductors,

Reference Books:

1. Goldstein, H., Poole, C., & Safko, J. (2002). Classical Mechanics (3rd ed.). Addison-Wesley.
2. Griffiths, D. J. (2017). Introduction to Electrodynamics (4th ed.). Cambridge University Press.
3. Cohen-Tannoudji, C., Diu, B., & Laloë, F. (1977). Quantum Mechanics (Vol. 1 & 2). Wiley.
4. Pathria, R. K., & Beale, P. D. (2011). Statistical Mechanics (3rd ed.). Academic Press.
5. Arfken, G. B., & Weber, H. J. (2005). Mathematical Methods for Physicists (6th ed.). Elsevier Academic Press.
6. Millman, J., & Grabel, A. (1987). Microelectronics (2nd ed.). McGraw-Hill.
7. Herzberg, G. (1950). Molecular Spectra and Molecular Structure: Spectra of Diatomic Molecules (Vol. 1). Van Nostrand.
8. Kittel, C. (2005). Introduction to Solid State Physics (8th ed.). Wiley.

C. Basic Concepts of Computer