CHEM 401-0 Principles of Organic Chemistry

An accelerated one quarter course in organic chemistry (without laboratory) intended for graduate students in chemistry and related fields needing a working knowledge of the principles of organic chemistry. Topics include structure and reactions of organic molecules and an introduction to the strategy of organic synthesis. These topics approximately parallel those covered in Chemistry 212-1,2. This course may also be appropriate for graduate students or advanced undergraduates in other fields of science and engineering having little or no prior course work in organic chemistry. This course is not appropriate for Northwestern undergraduates who have completed Chemistry 210-1,2 or 212-1,2. Registration by Chemistry Department placement or by permission of the instructor only.

CHEM 407-0 Materials and Nanochemistry

This course introduces first year graduate students and seniors in chemistry to the field of materials and nanotechnology focusing on synthetic methods to create materials and nanostructures with specific functions. Following an introduction that defines "materials" and "nanoscience", the course covers specific synthetic strategies and methodologies. The first topic covered is polymerization chemistry, starting with basic principles followed by the most advanced methods known to synthesize polymers such as living free radical reactions, ring opening methathesis polymerization, recombinant DNA synthesis of polymers, and supramolecular noncovalent polymers. This is followed by topics in self-assembly of materials and nanostructures including liquid crystals, gels, self-assembly of amphiphiles, self-assembling monolayers, layer-by-layer assemblies, and colloidal crystals. The last third of the course covers chemical synthesis of ceramics, and synthesis of nanomaterials such as quantum dots, metal nanoparticles, graphene, and carbon nanotubes.

CHEM 408-0 Design, Synthesis, and Applications of Nanomaterials

Approaches to the rationale, physical and chemical synthesis, assembly and characterization of controlled dimensionality materials including metals, semiconductors, oxides, polymers, and mesoporous scaffolds. Topics will include interfacial phenomena and particle stability, nano-forms of carbon, and applications-driven material design.

CHEM 410-0 Physical Organic Chemistry

This course will focus on modern topics in physical organic chemistry, while emphasizing the relationship between structure and reactivity. Topics to be covered are molecular orbital theory, orbital symmetry and reactivity, stereoelectronic effects, transition state theory, electron transfer, free energy relationships, nucleophilic and electrophilic reactivity, kinetic isotope effects, and basic photochemistry.

CHEM 411-0 Organic Spectroscopy

NO DESCRIPTION AVAILABLE

CHEM 412-0 Organic Reaction Mechanisms

Elucidation of organic and organometallic reaction mechanisms: experiment, theory, and selected case studies.

CHEM 413-0 Organic Reactions

Strategies and tactics involved in complex target synthesis. Modern reaction classes as applied to chemical synthesis, coupled to in-depth d433(s)-3(e)-4B3(d)-4.9(as)-5(s)-1.31(a)0.9u-1.31(n3(e)-6(s)-4.3a)0.97(n)2.7(t)-5y(n

CHEM 415-0 Medicinal Chemistry: the Organic Chemistry of Drug Design and Action

This is a survey course designed to show how organic chemistry plays a major role in the design, development, and action of drugs. Although concepts of biology, biochemistry, pharmacy, physiology, and pharmacology will be discussed, it is principally an organic chemistry course with the emphasis on physical interactions and chemical reactions and their mechanisms as applied to biological systems. We will see how drugs are discov hi0rdC

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CHEM 434-0 Inorganic Chemistry

This course will be focused on magnetism and electronic structure of transition metal complexes. By the end of the course students will learn how to acquire and interpret magnetic data for transition metal complexes. The primary focus of the course will be molecular species.

CHEM 435-0 Advanced Inorganic Chemistry: Chemical Structure and Bonding

This purpose of this course is to present a number of topics that highlight the influence of electronic structure in coordination compounds on determining molecular and solid-state structure, bonding, reactivity, and magnetic behavior. Of particular focus are topics not commonly covere-3.2(n)-0.8()-6(i)-6(c)-4.(art)-3(ic)2a

- Tunneling in chemistry
- Diatomic molecules
  - Separation of the center-of-mass and internal modes
  - Rotations in a 2D world
    - Rotor on a surface: STM-induced rotation in DCCD/Cu
  - Rotations in 3D & Angular momentum within the Schrodinger picture
  - Molecular vibrations
    - The harmonic oscillator model (within Dirac's approach)
    - Anharmonic vibrations
      - Time-independent perturbation theory
      - Numerical solution of eigenvalue problems
    - The correspondence principle in the context of the harmonic oscillator
    - Vibrational wavepackets
      - Pump-probe experiments in vibrational wavepackets
      - Vibrational dephasing, vibrational revivals
- A brief introduction to polyatomic molecules
- One-electron atoms
  - The Schrodinger equation, eigenstates and frequency-resolved spectra (a brief review)
    - Electronic wavepackets and the classical limit
- Two-electron atoms
  - Variational methods
  - Angular momentum within Dirac's approach
  - The electron spin
    - The Stern-Gerlach experiment

x <u>Current Directions and Open Questions</u>

- Schroedinger's cat
- The Einstein-Podolsky-Rosen Paradox
- Bell's Theorem
- Quantum Erasure

**Review of relevant topics in mathematics will be provided in the first few of weekly exercises.

CHEM 444-0 Elementary Statistical Mechanics

Topics: (1) Thermodynamics, Fundamentals (2) Foundations: Microcanonical, canonical, and generalized ensembles (3) Theory of Phase Transitions (4) Equilibrium and Stability (5) Non-interacting systems (6) Ising Model (7) Fluctuation Dissipation

CHEM 445-0 Analytical Chemistry

Principles and applications of analytical methods, with emphasis on advanced separation science, dynamic electrochemistry, and advanced mass spectrometry.

CHEM 445-0 Advanced Physical Chemistry: Modern Spectroscopy

NO DESCRIPTION AVAILABLE

CHEM 448-0 Computational Chemistry

The aim of this course is to study the application of modern computer technology, in combination with theoretical chemistry methods, to molecular problems. Each student is expected to complete a series of