**Course Description**

TITLE : **SC2.101** GENERAL AND STRUCTURAL CEMISTRY

CREDITS : (L = 4, T= 0, P = 0, C= 4)

TYPE : Core for CND

FACULTY NAME : Tapan K. Sau

NUMBER OF STUDENTS : ……………………..

OBJECTIVES: This course is designed for the undergraduate students in CND. It will provide students with important background information in the selected topics of general and structural chemistry. The coverage will include an overview of basic quantum mechanical treatments of atoms and molecules, modern materials, and some relevant major experimental techniques that provide important information on the structure and properties.

**COURSE TOPICS:**

1. THE STRUCTURE OF ATOMS – A BASIC QM TREATMENT (2L)

Quantization of the energy levels; quantum numbers; s, p, d and f atomic orbitals; Pauli’s Exclusion Principle and Hund’s Rule of Maximum Multiplicity.

1. CHEMICAL PERIODICITY (2L)

Periodic classification of elements; Atomic Radius; Ionic Radius; Ionization Energy; Electron Affinity; Polarizability; The Inert-Pair Effect; Diagonal Relationships; Chemistry with emphasis on group relationship and gradation in properties (metals and non-metals; Main Group Elements (s and p blocks); Transition Metals (d block): 3d elements); Relativistic Effects.

1. CHEMICAL BONDS, MOLECULAR GEOMETRY AND STRUCTURE (6L)
2. Ionic Bond Formation and Lattice Energy
3. Covalent Bonding; Valence-Bond Theory; Molecular Orbital Theory; How do we know that electrons are not paired; How do we know the energies of MOs? Major technique: XPS.
4. Strengths and Lengths of a Bond; How do we know the length of a bond? How do we know the strength of a bond? Major techniques: Rotational & Vibrational Spectroscopies.
5. VSEPR Model.
6. ISOMERISM: Types; Optical isomerism in compounds (containing one and two asymmetric centers); Isomerism in coordination compounds; Major Techniques: Chromatography/Mass Spectroscopy

1. COORDINATION COMPOUNDS (2L)

The Shapes of Complexes; The electronic structures of complexes: Crystal Field Theory; Ligand Field Theory; Color and magnetic properties; Major technique: UV-Vis Spectroscopy.

1. SOLIDS AND MODERN MATERIALS (4L)

Solid structures; Bonding in the Solid State; Semiconductors; Superconductors; Luminescent Materials; Magnetic Materials; Composite Materials; Nanomaterials; Major Technique: XRD

1. POLYMER MATERIALS: SYNTHETIC AND BIOLOGICAL (2L)

Synthetic Polymers: Synthesis of Organic Polymers; Electrically Conducting Polymers; Biological Polymers: Proteins and Nucleic Acids; Major Techniques: NMR & CD spectroscopy

1. LIQUIDS (1L)

Intermolecular forces; Liquid structure; Liquid Crystals; Ionic Liquids

1. PROPERTIES OF SOLUTIONS (2L)

Solubility and Common ion effect; Vapor Pressure; Colligative Properties; How to use colligative properties to determine the molar mass? The impact on biology and materials: Colloids; Biomimetic materials

1. SOLUTION CHEMISTRY (2L)

Bronsted-Lowry Acids; Buffers; Polyprotic systems

1. KINETICS (3L)

Mechanism of chemical reactions; Activated Complex Theory; Reactions in Solution; Reaction Dynamics; Enzymatic Catalysis

**PREFERRED TEXTBOOKS:**

1. Peter Atkins and Loretta Jones (2010), *Chemical Principles: The Quest for Insight*, 5th Edition, W. H. Freeman and Company, New York.

2. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, Matthew W. Stoltzfus (2018), *Chemistry: The Central Science*, 14th Edition, Pearson Education, Harlow, United Kingdom.

**REFERENCE BOOKS:**

1. Donald A. McQuarrie, Peter A. Rock, and Ethan B. Gallogly (2011), *General Chemistry*, 4th Edition, University Science Books, California.

2. Raymond Chang and Jason Overby (2011), *General Chemistry: The Essential Concepts*, 6th Edition, (McGraw-Hill, New York.

3. Martin S. Silberberg (2013), *Principles of General Chemistry*, 3rd Edition, McGraw-Hill, New York.

**\*PROJECT: None**

**GRADING:** Student assessment will be based on:

1. Assignments: 15%
2. Quizzes (2\*10): 20%
3. Mid-Sem Exam: 20%
4. End-Sem Exam (***WHOLE Syllabus***): 45%

**NOTE: Students who do not appear for either Mid Sem or End Sem (or their REPEAT Exams) will be given 'F' grade.**

**OUTCOME:**

**CO 1**. Define quantum numbers for electrons, draw orbital diagrams, and state and apply the Pauli Exclusion Principle and Hund’s Rule to write the electronic configurations of atoms.

**CO 2**. Explain the position of elements in the periodic table and the general periodic trends in atomic size, ionic size, ionization energy, etc. of elements.

**CO 3**. State why chemical bonds form, identify the types of bonding that occur between metals/metal-nonmetal/nonmetal-nonmetal, state the current bonding models for simple inorganic and organic molecules, and predict important bonding parameters, structures, and properties.

**CO 4**. Compare the various acid­ base theories, identify acid­-base conjugate pairs, predict the strengths of acids and bases, and describe the properties of acids and bases.

**CO 5**. Apply bonding theories of coordination compounds to explain their optical and magnetic properties.

**CO 6**. Describe the properties and applications of various modern materials like semiconductors, superconductors, magnetic materials, polymers and composite materials, and nanomaterials.

**CO 7**. Distinguish intermediates and transition state; use chemical reaction theories to explain chemical reactions and their rates.

**CO 8**. Be able to describe how chemistry plays the central role in modern science.