# Course Outline
## Part A-Introduction

**Course Code**: 0531-14-513IA
**Course Title**: Advanced Inorganic and Material Chemistry
**Course Type:** Core Course
**Year/Semester**: M.Sc. 1st Semester
**Academic Session**: 2019-20
**Course Teacher**: Mohammad Sayadur Rahaman
**Pre-requisite (If any)**: Not Required
**Credit Value**: 4.0
**Contact Hours**: 56.0
**Total Marks**: 100
**Rational of the Course**:
Inorganic chemistry of materials includes those parts of inorganic chemistry or the chemistry of elements that can be used to make products. It is not one single subject but consists of several widely different disciplines, such as structural chemistry, coordination chemistry, and solid state ionics, to name but a few. Society and technology are underpinned by the solid state sciences. For example computing (data storage, CD lasers, batteries) construction (concrete, steels) transport (catalytic converters, fuel cells, strong lightweight materials) chemicals (catalysts, sensors) medicine (artificial joints, bones, and muscle) gems (jewellery, cutting tools, lasers)
**Course Objectives:**

- To promote knowledge on synthesis, structure, properties and applications of a range of new materials
- To impart knowledge on inorganic materials involve molecular inorganic superconductors, polymeric coordination complexes, precursors for electronic materials
- To convey knowledge on the nanomaterials synthesis

**Course Learning Outcomes (CLOs)**
After completion of the Course, the Student will be able to –

CLO-1: Demonstrate about the types of materials, bonding and structural pattern in solid state, and models or theories for predicting properties of materials.
CLO-2: Categorize the types of solid state reactions and interpret the kinetics of solid state reactions and growth of crystalline solids
CLO-3: Explore the properties of inorganic solid surfaces and inorganic colloids
CLO-4: Interpret chemical vapor deposition method and apply for solid state synthesis
CLO-5: Extract the extrinsic properties of inorganic materials and interpret the morphology control for fabricating properties of materials.
CLO-6: Develop the synthetic strategies/schemes for preparing inorganic materials.
CLO-7: Explain structure and properties of carbon based and other form of nanomaterial and their applications
CLO-8: Design a scheme/method for preparing inorganic materials of their intended use.

## Mapping of CLOs with Program Learning Outcomes (PLOs)

| | LT | LD | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CLO1** | C2 | FS | 3 | 1 | 1 | 1 | - | - | 1 | - |
| **CLO2** | C2 | FS | 3 | 1 | 1 | 1 | - | - | 1 | - |
| **CLO3** | C4 | FS | 3 | 1 | 1 | 1 | - | - | 1 | - |
| **CLO4** | C2 | FS | 3 | 3 | 1 | 1 | - | - | 1 | - |
| **CLO5** | C5 | FS | 3 | 1 | 2 | 1 | - | - | 1 | - |
| **CLO6** | C6 | TS | 3 | 1 | 3 | 1 | - | 1 | 1 | - |
| **CLO7** | C2/C3 | FS | 3 | 1 | 2 | 1 | - | - | 1 | - |
| **CLO8** | C6 | TS | 3 | 3 | 3 | 1 | - | 1 | 1 | - |

LT: Learning Taxonomy (Appendix-1); LD: Learning Domain (Appendix-2);
C: Cognitive; P: Psychomotor; A: Affective; FS: Fundamental Skill; TS: Thinking Skill

## Course Contents

| SL No. | COURSE CONTENTs | Hrs/ Lectures | Alignment to CLOs |
|---|---|---|---|
| 1. | The Technology of Materials; Types of Matter: Structure and Bonding: chemical change; Bonding in Ionic Compounds: The Miedema Model for Intermetallics, The Pearson Model: Electronegativity Equalization, Linnett's Localized Electron Model for Molecules, Johnson's Interstitial Electron Model for Metals | 8 | CLO1 |
| 2. | Solid State Reactions: Types of Reactions of Solids; Kinetics of Solid State Reactions; Measuring Solid State Reaction Kinetics; The Chemistry of Ceramics and Sintering. | 4 | CLO2 |
| 3. | The Chemistry of Inorganic Surfaces: Physical Properties of Inorganic Solid Surfaces; Inorganic Colloids; Heterogeneous Catalysis; Growth of Crystalline Solids from Liquids; Converting Solids by Reaction with a Gaseous Reactant; Chemical Vapor Deposition; High-Temperature Corrosion; Surface Modification by Immobilization of Molecules | 8 | CLO2 |
| 4. | Inorganic Morphogenesis: Introduction to the Chemistry of Microstructure and Nanostructure; Extrinsic Properties of Materials; Fractal Dimensions; Simulations of Reaction-Diffusion Processes Using. Cellular Automata; The Chemistry of Fractal Distributions: Processes that Generate Fractal Distributions and Reactions on Fractal Surfaces | 6 | CLO3 |
| 5. | Synthesis Strategy of Inorganic Materials: Introduction to Inorganic Synthesis; Solid State Reactions; Synthesis from Liquids: preparation from Melts, liquid Salts as Solvents, hydrothermal processes and sol-gel method; Gas-Phase Techniques | 8 | CLO6 |
| 6. | Carbon Based Nanosystem: Carbon nanotubes; Types of carbon nanotubes; Synthesis and application of carbon | 4 | CLO7 |

| | | | |
|---|---|---|---|
| | nanotubes; Graphene: structure, synthesis, properties and application | | |
| 7. | Chemistry and Catalytic Aspects of Nanocrystals: Chemistry occur at the nanocrystal surface; Nanostructured adsorbent; Nanoparticles as chemical reagents; Nanocomposite polymes; Application of nancrystals | 4 | CLO7 |
| 8. | The Design of Inorganic Materials: Introduction to Materials Design; Requirements and Constraints; Combination Properties of Composites: sum Properties, product Properties, and morphology; Functional Materials: thermistors, varistors and Active Materials; Fabrication of Composites | 8 | CLO8 |

## Part-B: Course Plan

| Week | Topic | Teaching-Learning Strategy | Assessment Strategy | Corresponding CLOs |
|---|---|---|---|---|
| 1 | Types of Inorganic Materials: Bonding and Structure | Lecturing and Student Activity | Quiz (Formative) & | CLO1 |
| 2 | Uses of Models/Theories for Inorganic Materials | Lecturing and Discussion | | CLO1 |
| 3 | Inorganic Reactions: Solid State Reactions | Lecturing | Quiz (Formative) and Summative (Final Exam) | CLO2 |
| 4 | Chemistry of Inorganic Surface | Lecturing | Summative (Final Exam) | CLO2 |
| 5 | Growth of Crystalline Solids from Liquids | Lecturing and Group Discussion | Summative (Midterm and Final Exam) | CLO5 |
| 6 | Chemistry of Microstructure and Nanostructure | Lecturing | Summative (Midterm and Final Exam) | CLO6 |
| 7 | Extrinsic Properties of Inorganic Materials | Lecturing and Flip learning | Assignment and Summative (Final Exam) | CLO3 |
| 8 | Synthesis Strategy of Inorganic Materials | Slide Presentation | Quiz and Assignment | CLO3 |
| 9 | hydrothermal processes and sol-gel method | Lecturing | Summative (Final Exam) | CLO4 |
| 10 | Green Synthesis of Inorganic Materials | Lecturing and Group discussion | Summative (Semester Final) | CLO5 |
| 11 | Nano-Material and their catalytic Properties | Activities | Summative (Semester Final) | CLO4 |
| 12 | Case Study on Manufacturing of Inorganic materials | Student Activity and Group Discussion | Summative (Midterm) | CLO4, CLO6 |
| 13 | Design of Inorganic Materials | Project Based Learning | Summative (Semester Final) | CLO5, CLO7 |
| 14 | Oral Presentation and Review of the course | Student Activity and Group Discussion | Presentation | CLO1-CLO7 |

## Part-C: Assessment and Evaluation

**Assessment Strategy**:

Assessment will measure the attainment of learning outcomes. Students are required to attain all learning outcomes in order to gain a pass mark. The use of grades or classifications, such as credit, merit and distinction are indicative of the level of achievements of the learning outcomes. Assessment methods would be consisted with both formative and summative assessment.

**Formative assessment** refers to tools that identify misconceptions, struggles, and learning gaps along the way and assess how to close those gaps. It includes effective tools for helping to shape learning, and can even bolster students' abilities to take ownership of their learning when they understand that the goal is to improve learning, not apply final marks (Trumbull and Lash, 2013). It can include students assessing themselves, peers, or even the instructor, through writing, quizzes, conversation, and more.

In contrast, **summative assessments** evaluate student learning, knowledge, proficiency, or success at the conclusion of an instructional period, like a unit, course, or program. Summative assessments are almost always formally graded and often heavily weighted (though they do not need to be).

Summative assessment can be used to great effect in conjunction and alignment with formative assessment, and instructors can consider a variety of ways to combine these approaches.

2) Marks distribution:

a) Continuous Assessment: 40%
- (i) Quiz (Formative Assessment) 10
- (ii) Assignment/Presentation 05
- (iii) Attendance and Class Participation 05
- (iv) Mid-Semester (Summative Assess.) 20

b) Semester Final Examination (Summative): 60%

| **Course Learning Outcomes (CLOs)** | **Assessment** | | | | |
|---|---|---|---|---|---|
| | **SMEF(Summative) 80%** | | **CA(Formative) 20%** | | |
| | **Midterm (20%)** | **Final Examination (60%)** | **Quiz (10%)** | **Assignment (5%)** | **Presentation (5%)** |
| CLO1: | Midterm-1 | FEQ | Q1 | | |
| CLO2 | | FEQ | Q2 | | |
| CLO3 | | FEQ | Q3 | Assignment | |
| CLO4 | | FEQ | | | |
| CLO5 | Midterm-2 | FEQ | Q4 | | |
| CLO6 | | FEQ | | | Presentation |
| CLO7 | | FEQ | | Assignment | Presentation |
| CLO8 | | FEQ | | | Presentation |

## Part-D: Learning Materials

1) Recommended Readings
    - Lalena, J.N. and Cleary, D. A.: Principles of Inorganic Material Design, 2nd Edition, Wiley, Printed I United States
    - William D. Callister, JR. and David G. Rethwisch, Materials Science and Engineering: AN INTRODUCTION, 9th Edition, Wiley 2014
    - Bodie E. Douglas, Darl H. McDaniel and John J. Alexander. *Concepts and Models of Inorganic Chemistry*, 3rd Edition, John Wiley & Sons, Delhi, 1994

2) Supplementary Readings
    - Advanced Chemistry Website, www.pearsonhigered.com/advchemistry
    - Gary L. Miessler, Paul J. Fischer and Donald A. Tarr. *Inorganic Chemistry*, 5th Edition, Pearson, New York, 2014
    - J.D. Lee. *Concise Inorganic Chemistry*, 6th Edition, Chapman & Hill, London
    - Solution Manual (ISBN: 0321814134) by Gary L. Miessler, Paul J. Fischer and Donald A. Tarr