

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**  
**HYDERABAD CAMPUS**  
**SECOND SEMESTER 2018-19**  
**Course Handout (Part II)**

Date: 07/01/2019

In addition to part -I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

**Course No.** : CHE F243  
**Course Title** : Materials Science and Engineering  
**Instructor-in-charge** : Nandini Bhandaru  
**Instructors** : Karthik Chethan V., Nandini Bhandaru

**Scope and Objective of the Course:**

The objective of the course is to introduce the fundamentals of materials science to Chemical Engineering undergraduate students. It gives a basic understanding of the structure (crystalline and amorphous) and properties (thermal, mechanical and electrical) of different types of materials such as metals, ceramics and polymers. The course also deals how the type of bonding, crystal structure, formation of structure (defects, diffusion, phase diagrams and phase transformation) and dynamics influence the properties of these materials.

**Learning Outcomes:**

- i. The students should be familiar and have gained some expertise with aspects of materials science (familiarity with materials and bonding, structure-property correlation, materials characterization and materials processing that is commonly encountered in chemical, ceramic, metallurgical, mining, pharmaceutical, food and biotechnology industries.
- ii. Since the course covers a large number of case studies in materials science, the students should attempt to hypothesize and propose to solve materials based issues in a confident and feasible manner by combining conceptual, numerical and design based solutions learnt during the course of the semester. The issues can be research, product development, process, quality control and application related.
- iii. The students should have learnt the skill of coupling micro and macro aspects of materials, to combine materials structure-characterization-property and to apply interdisciplinary skills of science and engineering in problem-solving.
- iv. Finally, the students should be comfortable and skillful in handling real-world projects that they would encounter in their future endeavors of practice school, placements and higher education.

**Text Book:**

**T1. MATERIALS SCIENCE AND ENGINEERING-AN INTRODUCTION** by WILLIAM D. CALLISTER, JR. Seventh Edition, John Wiley (2007)

**Reference Books:**

**R1. MATERIAL SCIENCE AND ENGINEERING** by V. RAGHAVAN, Fifth Edition, Prentice-Hall of India private Limited (2004)

**Course Plan:**

| Lect. No. | Learning Objectives                                     | Topics to be covered  | Chapter in the Text Book |
|-----------|---|---|--------------------------|
| 1         | Introduction  | Classification of Materials   | Ch. 2 (TB)               |
| 2         | Bonding in materials                                    | Bonding forces & Energies, Primary and Secondary bonds  | Ch. 2 (TB)               |
| 3-5       | Crystallography   | Unit cell, Crystallographic directions and planes, Crystalline and Noncrystalline materials   | Ch. 3 (TB)               |
| 6-8       | Metallic structures                                     | FCC, BCC, Linear and planar densities, close-packed crystal structures  | Ch. 4 (TB)               |
| 9         | Ceramic structures                                      | Crystal structures of ceramics  | Ch. 4 (TB)               |
| 10-11     | Polymer structures                                      | Molecular weight, Molecular configurations of polymers, and Polymer crystallinity   | Ch. 4 and 13 (TB)        |
| 12-13     | X-ray diffraction                                       | Determination of crystal structure, Bragg's Law, Diffraction technique  | Ch. 4 (TB)               |
| 14-16     | Defects and Dislocations                                | Vacancies and interstitials, dislocations and grain boundaries  | Ch. 5 (TB)               |
| 17-19     | Diffusion   | Diffusion mechanisms  | Ch. 6 (TB)               |
| 20-23     | Phase diagrams  | Phases, Microstructure, Phase equilibrium, Iron-Carbon system, Development of microstructure in Fe-C alloys   | Ch. 7 (TB)               |
| 24-26     | Phase Transformations                                   | Avrami rate equations, Isothermal transformation, Continuous cooling transformation diagrams  | Ch. 8 (TB)               |
| 27-29     | Mechanical Properties of materials and characterization | Stress-Strain, Elastic and plastic deformations, Mechanical properties and behavior of Fe-C alloys.   | Ch. 9 (TB)               |
| 30-31     | Deformation mechanisms                                  | Fractography, Slip systems, plastic deformation, strengthening mechanisms, Viscoelastic deformation, fracture behavior in metals, ceramics and polymers | Ch. 10 (TB)              |
| 32-34     | Thermal properties of materials and characterization    | Glass Transition, Crystallization and Melting Phenomenon, calorimetry, thermal conductivity   | Ch. 19 (TB)              |
| 35-37     | Electrical Properties of Materials and characterization | Electrical characteristics of Metals, Ceramics and Polymers, dielectric spectroscopy, piezoelectrics  | Ch. 17 (TB)              |
| 38-39     | Magnetic Properties of materials and characterization   | Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis, Superconductivity  | Ch. 18 (TB)              |
| 40-42     | Composite materials                                     | Fibre phase, Matrix phase, PMC (polymer matrix composite, interfaces and characterization   | Ch. 15 (TB)              |

**6. Evaluation Scheme:**

| Component                           | Duration | Weightage | Date & Time            | Nature of Component |
|-------------------------------------|----------|-----------|------------------------|---------------------|
| Quiz (min 4)                        | TBA      | 20 %      |                        | Open book           |
| Assignments & Presentations (min 3) | TBA      | 20%       |                        | Open book           |
| Mid-Term Exam                       | 90 min   | 20 %      | 12/3<br>9.00 - 10.30AM | Closed book         |
| Comprehensive Exam.                 | 3 hours  | 40 %      | 03/05 FN               | Open book           |

**Chamber Consultation Hour:** To be announced later.

**Notices:** All notices related to the course will be uploaded in CMS.

**Make-up Policy:** Make-up will be granted for genuine cases with prior approval.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

***Nandini Bhandaru***  
**INSTRUCTOR-IN-CHARGE**