| BMEE209L | Materials Science and Engineering | L | T | P | C |
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| **Pre-requisite** | **BPHY101L , BPHY101P , BCHY101L , BCHY101P** | **Syllabus version** | | | |
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**Course Objectives**

1. To impart knowledge on the correlation between structure-property of materials.
2. To provide knowledge on mechanical properties of materials and strengthening mechanisms.
3. To give insight into advanced materials such as polymers, ceramics and composites and their applications.

**Course Outcomes**

At the end of the course, the student will be able to

1. Compare different structures based on the atomic arrangement.
2. Examine various phases of metals and alloys using phase diagrams.
3. Assess the mechanical behaviour of materials according to the standards.
4. Recommend suitable heat treatment and surface hardening processes.
5. Propose the suitable material based on the structure-property relationships.

| Module:1 | Fundamentals to Materials engineering | 3 hours |
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Historical perspective of materials, materials science, Materials engineering, Materials classification, Materials tetrahedron, Engineering requirement of advanced materials and smart materials – Diversified applications.

| Module:2 | Crystallography and Defects | 6 hours |
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Fundamental Concepts, Crystal geometry, Unit Cell, Classification of Lattices – Bravais Lattice - Point coordinates, Crystallographic Directions and Planes, Weiss zone law applications - Single and Poly crystalline materials, Non-crystalline/Amorphous Materials. Crystal Structure of Metals, Ceramics and Polymers, Defects in crystals – point defects, line defects (dislocations), Characteristics of Dislocations, Slip Systems, Slip in Single Crystal, Deformation by Twining, surface defects and volume defects, Microscopic examination.

| Module:3 | Solidification, Diffusion and Phase Transformation | 8 hours |
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Nucleation - Homogeneous and Heterogeneous Nucleation- Growth of crystals- Planar growth – dendritic growth. Diffusion: Introduction – Fick's Law of Diffusion - Diffusion Mechanisms, Steady state and non-steady state diffusion. Basics of phase diagram, Gibb's phase rule, Lever rule, Unary phase Diagrams, Binary Isomorphous and Eutectic Systems, Interpretation of Phase Diagram, Iron – iron carbide phase diagram – Slow cooling of hypo and hyper eutectoid steels, Phase transformations in steels and cast iron.

| Module:4 | Mechanical behaviour of Materials | 7 hours |
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Hardness Testing of Materials, Tensile properties of the materials, Effect of strain rate, Impact Testing, Fracture of Metals – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Fatigue – Endurance limit, Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; Creep and stress rupture– mechanism of creep – stages of creep and creep test, Mechanisms of Strengthening in Metals and alloys.

| Module:5 | Heat Treatment | 7 hours |
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Isothermal Transformation diagrams and Continuous Cooing Transformation diagram. Principles of heat treatment, Annealing, Concept of Recovery, Recrystallization and Grain Growth, Normalizing, Hardening, Tempering, Solutionizing, Ageing, Special heat treatment processes: Austemepering, Martempering, Ausforming, Hardenability of steel, Microstructure changes during heat treatment.

Surface hardening processes - Carburizing – Nitriding – Cyaniding and carbo-nitriding, Induction and flame hardening, Laser and Electron beam hardening.

| Module:6 | Metallic Materials | 6 hours |
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Steels – Types of Steels, Effect of alloying elements on structure and properties of steels,

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| Alloy Steel – Tool and Die Steel, Stainless steel, Speciality steel, Cast iron- White, Grey, Malleable and Nodular - Properties and application of cast irons. Non-ferrous Alloys, Aluminium, copper, Nickel, Magnesium and Titanium. | | |
| **Module:7** | **Non-metallic and Composite Materials & Economic, Environmental, and societal issues in materials Science and Engineering** | **6 hours** |
| Ceramics: types, properties and application of ceramics; Glass: classification of glass, properties and application of glass; Polymer: classification of polymers - properties and application of polymers; Fibers: Natural Fibers/Synthetic Fibers; Composites: Classification of Composite Materials, Properties and Application of Composite Materials. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
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| | **Total Lecture hours:** | **45 hours** |

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| **Text Books** | |
| 1. | William D. Callister Jr., David G. Rethwisch, Callister's Materials Science and Engineering, 2018, 10th edition, John Wiley & Sons, Inc., United states. |
| 2. | William F Smith, Javad Hasemi and Ravi Prakash, Materials science and Engineering, 2017, 5th edition, McGraw Hill Publications. |
| **Reference Books** | |
| 1. | Michael F. Ashby, Materials Selection in Mechanical Design, 2016, 5th edition, Elsevier Butterworth-Heinemann. |
| 2 | Donald R. Askeland, Science and Engineering of Materials, SI Edition, 2015, 7th edition, Springer, Boston, MA. |
| 3 | Raghavan V, Materials Science and Engineering, 2015, 6th edition, Prentice Hall India Learning Private Limited, United Kingdom. |
| 4 | Sidney Avner, Introduction to Physical Metallurgy, 2017, 2nd edition, McGraw Hill Education |

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| Mode of Evaluation: CAT / Written assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 09-03-2022 | | |
| Approved by Academic Council | No. 65 | Date | 17-03-2022 |