

| Course Code | Course Name       | Credits |
|-------------|-------------------|---------|
| 26PH612     | MATERIALS SCIENCE | 04      |

### Course Objectives

- To know the basic concepts in materials science and characterization of materials.
- To understand the structure and properties of various materials and the working of characterization techniques.
- To choose materials based on characterization of properties for appropriate applications.
- To analyze and evaluate various properties of materials.
- To develop and suggest materials design for practical problems and applications.

### Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Analyze elastic/plastic deformation, strengthening mechanisms, binary phase diagrams, iron-carbon transformations, metal fabrication, and thermal processing applications.
- Evaluate ceramic crystal structures, silicate/carbon phases, mechanical properties, plastic deformation, fabrication methods (powder pressing, tape casting, 3D printing), and glass-ceramics applications.
- Understand polymer chemistry, molecular weight/shape, thermoplastics/thermosets, stress-strain behavior, glass transition, polymerization, and advanced biomaterials.
- Design particle/fiber-reinforced composites (polymer/metal/ceramic/carbon matrix), hybrid nanocomposites, processing techniques, and laminar/sandwich structures.
- Apply characterization techniques including XPS/AES, STM/AFM, XRD, TEM/SEM, IR/UV-Vis spectroscopy, and thermal analyses for material property analysis.

### Unit 1 – Metal Alloys (12 Hrs.)

Elastic deformation– Stress-Strain behaviour- Anelasticity- Elastic properties- tensile properties-Hardness Mechanism of strengthening in metals- Binary Phase diagrams- Phase transformation-microstructural and property changes in Iron-carbon alloy- types of metal alloys- fabrication - thermal processing of metals Applications.

### Unit 2 – Ceramics (12 Hrs.)

Ceramic structure- crystal structure-silicate ceramics- Carbon-Ceramic Phase diagrams-mechanical properties- Stress-Strain Behaviour -mechanics of Plastic deformation- types of ceramic-fabrication and processing of ceramics- glasses and glass-ceramics- clay- powder pressing-tape casting- 3D printing Applications of ceramics.

### Unit 3 - Polymers (12 Hrs.)

Hydrocarbon molecules- Polymer molecules-chemistry of polymer molecules – molecular weight-shape structure- Thermoplastics and thermos settings- -stress strain behaviour-polymer types-Glass transition temperature – polymerization-polymeric biomaterials-Advanced polymeric materials.

### Unit 4 – Composites (12 Hrs.)

Particle-Reinforced Composites-Fibre- Reinforced Composites-Polymer -matrix composites-metal matrix composites- ceramic matrix composites- carbon -carbon composites-hybrid composites- -Processing of Fibre-Reinforced Composites -laminar composites- sandwich panels – Nanocomposites.

### Unit 5 - Material Characterization (12 Hrs.)

Principle and Instrumentation: X-Ray Photoelectron spectroscopy and Auger Electron Spectroscopy Scanning Tunnelling Microscopy and Atomic Force Spectroscopy– X-Ray Diffraction- Transmission Electron Microscopy- Scanning Electron Microscopy - Infrared Spectroscopy and UV/Vis Spectroscopy - Macro and Micro Thermal Analyses.

### Reference Books:

1. Callister, Jr. W. D., &Rethwisch, D. G. (2018). Materials Science and Engineering an Introduction, (10th Ed.). Wiley.
2. Zhang, S., Li, L., & Kumar, A. (2008). Materials Characterization Techniques. CRC Press.
3. Gowariker, V. R., Viswanathan, N. V., &Sreedhar, J. (2005). Polymer Science. New Age International (P) Ltd. M Sc Physics 46
4. *Nanomaterials and Nanocomposites: Characterization, Processing and Applications*-D. Babu and C. Kumar. (2021)

### Websites and eLearning Sources:

1. [https://onlinecourses.nptel.ac.in/noc24\\_mm12/preview](https://onlinecourses.nptel.ac.in/noc24_mm12/preview)
2. [https://youtu.be/abWi5y6bJ9k?si=Ybt1Hlz5ov\\_F0oNc](https://youtu.be/abWi5y6bJ9k?si=Ybt1Hlz5ov_F0oNc)
3. [https://youtu.be/388TPL5M9us?si=\\_Jngd-RLg4r4Czrm](https://youtu.be/388TPL5M9us?si=_Jngd-RLg4r4Czrm)

**COs and Bloom's Taxonomy Mapping – 26PH612**

| <b>Course Outcomes</b> | <b>On successful completion of this course, students will be able to</b>  | <b>BTL</b> |
|------------------------|---|------------|
| <b>CO1</b>             | Recall and explain mechanical behavior, phase transformations, and properties of metal alloys.                  | K1, K2     |
| <b>CO2</b>             | Apply concepts of structure, processing, and properties of ceramics and polymers.                               | K3         |
| <b>CO3</b>             | Analyze composite materials including fibre-reinforced and nanocomposites and their performance.                | K4         |
| <b>CO4</b>             | Analyze material characterization techniques such as XRD, SEM, TEM, spectroscopy, and thermal analysis.         | K5         |
| <b>CO5</b>             | Evaluate and design advanced materials with suitable properties for engineering and technological applications. | K6         |

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

**Relationship Matrix – 26PH612**

| <b>Course Outcomes</b> | <b>Programme Outcomes (POs)</b> |            |            |            |            |            | <b>Programme Specific Outcomes (PSOs)</b> |             |             |             |             |             | <b>Mean Score of Cos</b> |
|------------------------|---------------------------------|------------|------------|------------|------------|------------|---|-------------|-------------|-------------|-------------|-------------|--------------------------|
|                        | <b>PO1</b>                      | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PSO1</b>                               | <b>PSO2</b> | <b>PSO3</b> | <b>PSO4</b> | <b>PSO5</b> | <b>PSO6</b> |                          |
| <b>CO1</b>             | 3                               | 2          | 1          | 1          | 1          | 1          | 3   | 2           | 1           | 1           | 1           | 1           | 1.50                     |
| <b>CO2</b>             | 3                               | 3          | 2          | 2          | 1          | 1          | 2   | 3           | 2           | 2           | 2           | 1           | 2.00                     |
| <b>CO3</b>             | 3                               | 3          | 3          | 2          | 2          | 1          | 2   | 3           | 3           | 2           | 2           | 2           | 2.33                     |
| <b>CO4</b>             | 3                               | 3          | 3          | 3          | 2          | 2          | 2   | 3           | 3           | 3           | 2           | 2           | 2.50                     |
| <b>CO5</b>             | 3                               | 3          | 3          | 3          | 3          | 2          | 3   | 3           | 3           | 3           | 3           | 2           | 2.75                     |
| <b>Total</b>           |                                 |            |            |            |            |            |   |             |             |             |             |             | 2.22                     |

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

