AMITY UNIVERSITY
UTTAR PRADESH

COURSE CURRICULUM

Course Title: Engineering Materials
Course Level: UG
Course Code:

Credit Units: 4

L	T	P	S	SW	FW	TOTAL CREDIT UNITS
3	0	2	0	0	0	4

Course objectives:

The main objective of this course is to develop intuitive understanding of the groundwork for studies in fields such as solid-state physics, mechanical behavior of materials, phase & phase diagram, heat treatment, failure of materials & their protection, applications of recent materials to present a wealth of real world engineering examples to give students a feel of how material science is useful in Mechanical Engineering practices.

Pre-requisites: Applied Physics, Elements of Mechanical Engineering.

Course Contents/Syllabus:

	Weightage (%)
Module I: Atomic structure and bonding in materials	**15**
Descriptors/Topics Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Concept of amorphous, single and polycrystalline structures and their effect on properties of materials. Crystal growth techniques. Imperfections in crystalline solids and their role in influencing various properties.	
Module II: Properties of Materials	**25**
Descriptors/Topics Mechanical Properties: Stress-strain response of metallic, ceramic and polymer materials, yield strength, tensile strength and modulus of elasticity, toughness, plastic deformation, fatigue, creep and fracture. Electronic Properties: Free electron theory, Fermi energy, density of states, elements of band theory, semiconductors, Hall effect, dielectric behavior, piezo, Ferro, pyroelectric materials. Magnetic Properties: Origin of magnetism in metallic and ceramic materials, Para-magnetism, diamagnetism, Ferro and ferrimagnetism. Thermal Properties: Specific heat, thermal conductivity and thermal expansion, thermoelectricity. Optical Properties: Refractive index, absorption and transmission of electromagnetic radiation in solids, electro-optic and magneto-optic materials, spontaneous and stimulated emission, gas and solid state lasers, Corrosion and oxidation of materials and its preventions.	

Module III: Type of Engineering Materials	**20**
Descriptors/Topics Metals and Alloys: Solid solutions, solubility limit, Gibb's phase rule, binary phase diagrams, intermetallic compounds, iron-carbon and iron-iron carbide phase diagram, cold and hot working of metals, recrystallization and grain growth. Microstructure, properties and applications of ferrous and non-ferrous alloys. Ceramics: Structure, properties, processing and applications of traditional and advanced ceramics. Polymers: Classification, polymerization, structure and properties, additives for polymer products, processing and applications. Composites: Properties and applications of various composites.	
Module IV: Diffusion and Heat Treatment	**20**
Descriptors/Topics Powder synthesis, sintering, chemical methods, zone refining, preparation of nanoparticles and thin films. Fick's laws and application of diffusion in sintering, doping of semiconductors and surface hardening of metals. Various types of heat treatments such as Annealing, Normalizing, Quenching, Tempering (Austempering, Martempering), and various case hardening processes. Time Temperature Transformation (TTT) diagram.	
Module V: Advanced Materials and Tools	**20**
Descriptors/Topics Smart materials, biomaterials, super-alloys, shape memory alloys, nanomaterials, lasers and optical fibers, exhibiting ferroelectric, piezoelectric, opto-electric, semi-conductive, photoconductive and superconductive properties and applications. Materials characterization techniques such as X-Ray diffraction, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunneling microscopy, atomic absorption spectroscopy, and differential scanning calorimetry.	

Student Learning Outcomes:
On successful completion of this course, the student will be able to:

1. ***Recall*** the basic terms related to atomic and molecular level of materials.
2. ***Explain*** the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.
3. ***Apply*** the concept of mechanical behavior of materials and calculations of same using appropriate equations
4. ***Analyze*** the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions
5. ***Comply*** and suggest the heat treatment process & types. Significance of properties Vs microstructure. Surface hardening & its types. Introduce the concept of hardenability & demonstrate the test used to find hardenability of steels
6. ***Interpret*** features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.

Pedagogy for Course Delivery:
The course pedagogy will include lectures, case studies, seminars and presentations. It also includes discussion on real life problems and applications of different materials.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total (%)
75	25	100

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment					End Term
Components	**A**	**CT**	**S/V/Q**	**HA**	**EE**
Weightage (%)	5	10	8	7	70

Lab/ Practical/ Studio Assessment:

	Continuous Assessment/Internal Assessment				End Term Examination	
Components (Drop down	**A**	**PR**	**LR**	**V**	**PR**	**V**
Weight age (%)	5	10	10	5	35	35

List of Experiments:

1. To determine the crystal structures of a given specimen using optical microscopy.
2. To study Bravais lattices with the help of models.
3. To study heat treatment processes (hardening and tempering) of steel specimen.
4. To study thermo-setting of plastics.
5. To study the creep behavior of a given specimen.
6. To perform the molecular simulation using open form software.
7. To study the mechanism of chemical corrosion and its protection.
8. To study the properties of various types of plastics.
9. To study crystal structures and crystals imperfections using ball models.
10. To learn about the correlations among different types of hardness measurement and correlations of hardness with tensile strength.
11. Determination of material properties from stress-strain curves obtained from tensile tests.
12. Familiarize with methods for toughness measurement with impact tests.

Text Reading:

1. William D., Jr. Callister and David G. Rethwisch, "Materials Science and Engineering: An Introduction". Wiley and Sons; 8th edition (December 30, 2009); Language: English; ISBN-10: 0470419970.
2. R. K. Rajput**, "**A Textbook of Material Science**".** S.K. Kataria & Sons, 2013, ISBN 13: 9789350144183
3. James F. Shackelford, "Introduction to Material Science for Engineers". Pearson Education, 2014, ISBN 13: 9780133826654
4. A.V.K. Suryanarayana, "Material Science and Metallurgy". BS Publications, 2014. ISBN: 9789385433474.

References:

1. William D Callister, “Fundamentals of Materials Science and Engineering: An Integrated Approach”. Wiley, 2007 ISBN 13: 9780470125373.
2. Tariq A. Khraishi and Marwan S. Al-Haik, “Experiments in Materials Science and Engineering”. Cognella San Diego, CA, 2011. ISBN: 978-1-60927-868-
3. V. Raghavan, “Materials Science and Engineering: A First Course”. PHI Learning, ISBN 13: 9788120350922.
4. R. K. Rajput, “Engineering Materials”. S Chand & Co Ltd, 2000, ISBN 13: 9788121919609.

Additional Reading:

- http://nptel.ac.in/courses/113106032/
- http://nptel.ac.in/downloads/112108150/
- http://www.nptelvideos.in/2012/11/materials-science.html
- http://www.nptelvideos.com/applied_mechanics/material_science_video_lectures.php