Course Syllabus
Faculty of Technology
Semester-1

Subject: Advance Engineering Materials

Type of course: Elective-II

Prerequisite: Materials

Rationale:

Course gives idea about the behavioral properties of various materials. Also, internal structure and its relation to material's property are established in this subject. Subject is also useful for proper materials selection for various engineering applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
1	3	2	4	60	30	10	20	30	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1		10
2		10
3		10
Total		30

Course Content:

Sr. No	Course content	Hrs	% Weightage
1	**Introduction, Atomic Structure, Inter atomic Bonding and Structure of Crystalline Solids:** Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and non-crystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers. Structure and properties of ceramics.	6	14%
2	**Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms:** Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion.	8	19%
3	**Phase Diagrams:** Equilibrium phase diagrams, Particle strengthening by precipitation, Precipitation reactions, Kinetics of nucleation and growth, The iron carbon system, Phase transformations, transformation rate effects and TTT diagrams, Microstructure and property changes in iron-carbon system.	7	17%
4	**Failure:** Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects.	7	17%
5	**Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites:** Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. fibre reinforced composites. Structural composites.	6	14%
6	**Electrical, Thermal, Optical and Magnetic Properties and economic Considerations:** Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behaviour. Ferroelectricity. Piezoelectricity Heat capacity.		

	Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism. Anti ferromagnetism and ferrimagnetism. influence of temperature on magnetic behaviour. Domains and Hysteresis, Basic concepts. Optical properties of metals. Optical properties of non-metals. Application of optical phenomena. economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design.	8	19%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (**Revised Bloom's Taxonomy**)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	10%	15%	15%	10%	10%	10%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites.
CO2	Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure.
CO3	Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact.
CO4	Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites.
CO5	Understand the economic considerations in usage and recycling of materials in human use.

List of Practical

Sr. No	Descriptions	Unit No	Hrs
1	Identification of engineering materials	1	3
2	Preparation of bravais lattice and crystal geometry	3	2
3	Preparation of specimen and examination	3	4
4	Exercise for mounting techniques	2	3
5	Exercise on liquid penetration test	4	4
6	Exercise on magnetic particle test	5	2
7	Exercise on ultrasonic test	5	4
8	Testing of Rockwell hardness	5	4
9	Effect of quenching media	6	4
10	Testing of jominy hardenability	5	4

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons

2. Modern Physical Metallurgy and Material Engineering, Science, Process, application,Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.

3. Materials Science and Engineering, V. Raghvan, Pearsion Education

4. Introduction to Physical Metallurgy, S. Avner, McGraw Hill