

GUJARAT TECHNOLOGICAL UNIVERSITY

METALLURGY ENGINEERING (21)

ADVANCED MATERIALS

SUBJECT CODE: 2152109

B.E. 5th SEMESTER

Type of course: Engineering Science

Prerequisite: Knowledge of Basic Metallurgy and common Engineering Materials

Rationale: Materials have an important role in every field of engineering. The materials we use and how we make them can determine the function, feasibility, cost, environmental impact and many other aspects of things we create. Advanced Materials are the materials used in "High-Tec" applications, usually designed for maximum performance. Examples are titanium alloys for supersonic airplanes, magnetic alloys for computer disks, special ceramics for the heat shield of the space shuttle, etc. Metallurgy engineers design new materials, select the best material for a particular job, monitor its performance and figure out why a material failed and bring expertise on the properties of materials. To do this, Metallurgy engineers need to understand that how materials are made, its structure/composition, how and why materials are useful, what is the limit of materials and how materials can be made better or create a new material that will have some desirable properties. The Advanced Materials course is to prepare students for careers in metallurgy engineering where knowledge of Properties and applications of different Advanced Materials can be applied for the selection of candidate material for a given task. This course will enable students to solve metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	0	4	70	20	10	0	0	0	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Special steels Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc..	14	24
2	Alloy cast iron Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.	05	8
3	Light metals and their alloys Aluminium, magnesium and titanium alloys: Metallurgical aspects, Properties and applications.	05	8
4	Super alloys Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.	06	10
5	Rapid Solidification	06	10

	Metallic glasses, Atomic arrangement, Comparison with crystalline alloys, properties & applications, Glass transition temperature, Glass forming ability, Techniques for Production of metallic glasses.		
6	Nano materials Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.	06	10
7	Smart materials Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto-rheological fluids.	06	10
8	Biomaterials Property requirement, biocompatibility, bio functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications.	05	8
9	Miscellaneous Advanced Materials Magnetic materials, ceramics, composites and polymers, surface metal matrix composites, aerospace materials, and cryogenic materials, semi conducting and superconducting materials.	07	12

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	30	30	10	10	05

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

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.

Reference Books:

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI
9. Nano Technology by AK Bandyopadhyay, New age international publishers

Course Outcome:

After learning the course the students should be able to:

1. Explain various steels with their composition, advantages, limitations and application.
2. Select and compare different steel for a given metallurgical application.
3. Describe different alloy cast irons.
4. Explain the use of different types of light metal and their alloys with metallurgical aspects.
5. Explain different Super Alloys with their strengthening mechanism, composition properties and applications.
6. Explain technique to producing metallic glass.
7. Describe properties and applications of Nano materials.
8. Explain different smart material with their application.
9. Explain requirements of biomaterials and suggest a biomaterial for a given application.

List of Open Source Software/learning website:

1. <http://nptel.iitm.ac.in/>
2. www.ocw.mit.edu

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.