

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS (20)
\PRINCIPLES OF MATERIALS SCIENCE AND PHYSICAL METALLURGY
SUBJECT CODE: 2132004
B.E. 3rd Semester

Type of course: Engineering

Prerequisite: NA

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
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Contents:

Sr No	Contents	Teaching Hrs	Weightage (%)
1	Introduction: Basic concepts of material selection for various engineering applications, materials property requirements as per engineering applications, mechanical properties of metals, classification of metal alloys: types of ferrous alloys and non-ferrous alloys, micro and macro examination.	6	13.3%
2	Fundamentals of structure of crystalline solids: unit cells and crystal systems, crystallographic planes and directions, single crystal and poly crystalline materials, types of crystal structures, density computations, coordination number and atomic packing factor, closed packed crystal structures, x-ray diffraction method and Bragg's law for crystal structure determination, Imperfections in solids like point defects, dislocations – linear defects and interfacial defects.	9	20
3	Failure of Metals: fundamentals of fracture, ductile fracture, brittle failure, fatigue (cyclic stresses), creep.	4	8.8
4	Phase diagrams: definitions and basic concepts, the Gibb's phase rule, the ion-ion carbide phase diagram, development of micro structure in phase diagram and its percentage amount by weight, concept of phase transformations, kinetics of phase transformation, isothermal transformation diagram (TTT diagram), Jominy hardenability test	10	22.2

5	Heat treatment: various heat treatments such as normalizing, annealing, hardening, tempering, austempering, martempering, case hardening, nitriding, cyaniding, induction hardening, flame hardening, ageing. Application of heat treatments in mechanical components such as gears, bearings, crank shaft, turbine blade, etc.	8	17.7
6	Non-Destructive testing: radiography, liquid penetrate test, magnetic particle test, ultrasonic test, eddy current test	5	11.2
7	Powder metallurgy: production of powder, compacting, sintering, application in various fields, requirements of equipment.	3	6.8

Reference Books:

1. Callister's Materials Science and Engineering, William D. Callister, wiley publication
2. Materials Science and Engineering, V. Raghvan, Pearson Education
3. Introduction to Physical Metallurgy, S. Avner, McGraw Hill
4. Elements of Materials Science and Engineering, V. Vlack, Pearson Education
5. Materials Science, G. Narula, McGraw Hill
6. Material Science and Metallurgy, U.C. Jindal and Atish Mozumder, Pearson Education

Course Outcomes:

After successful completion of the course the students shall be able to:

1. Material Science & Metallurgy enhance the understandings of the students regarding the relationship between crystal structure, material properties and its fabrication process. The subject provides the information of the different properties of materials like, mechanical, thermal, optical, magnetic, Technological, etc
2. It also provides the knowledge regarding solidification of the metals & alloys and their phase transformation.
3. It also provides the exposure to students about different NDT methods.
4. It provides the knowledge of Heat treatment with material and powder metallurgy for enhancing the required properties in the material.

List of Practicals:

1. Identification of engineering materials
2. Bravais lattice and crystal geometry
3. Preparation of specimen and examination
4. Mounting techniques
5. Liquid penetration test
6. Magnetic particle test
7. Ultrasonic test
8. Rockwell hardness test
9. Effect of quenching media
10. Jominy hardenability test

Design based/open ended problem

Student may be given a task to design any technique to identify any material on hand and compile the procedure in a desired format for its proper representation. In addition to this students may also be asked to bring out the behavioral properties of given material under different environments.

Major Equipments:

1. Wet polishing bench
2. Engineering Microscope
3. Equipments/Accessories needed for non-destructive testing methods
4. Mounting press
5. Hardness tester
6. Furnace

Active learning Assignments (AL) : 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.