GANPAT UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Programme	Master of Technology			Branch/Spec.	Mechanical Engineering/ AMS/CAD/CAM
Semester	I			Version	2.0.0.0
Effective from Academic Year		2021-22		Effective for the batch Admitted in	July 2021
Subject code	**3ME1101**	Subject Name		**Material Science**	

Teaching scheme						Examination scheme (Marks)			
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	0	0	3	Theory	40	60	100
Hours	3	0	0	0	3	Practical	0	0	0

Pre-requisites:

Fundamentals of Materials Science and Metallurgy

Course Objective:

- To enhance the basic knowledge in the field of Material Science and Crystal imperfection.
- To learn the principles of material testing and characterization and to apply them for various engineering applications.
- To understand the fundamentals of ceramic, composite and polymer materials and to apply those fundamentals for selecting and developing materials for different engineering applications.
- To develop an understanding of the basis of physical metallurgy and correlate structure of materials with their properties for engineering applications.
- To provide a practical knowledge about corrosion and its prevention in engineering field.
- To understand the concepts on materials failure and fracture analysis of materials.

Theory syllabus

Unit	Content	Hrs
1	**CRYSTAL IMPERFECTION:** Introduction, Classification of crystal imperfection, Point imperfection, dislocations, and properties of dislocation, surface imperfection, Effect of imperfections on metal properties.	4
2	**PHASE TRANSFORMATIONS AND STRENGTHENING MECHANISMS:** Concepts of phase diagrams – phase transformations – significance of phase transformations – thermodynamic aspects of phase transformation-applications, strengthening mechanisms-solid solution hardening-precipitation hardening-grain refinement hardening-dispersion Strengthening-bainitic and martensitic transformations.	6
3	**FRACTURE:** Ductile fracture, brittle fracture, fracture toughness, ductile transition, mechanism of fracture.	4
4	**CREEP:** High temperature material, creep curve, stress-rupture test, deformation at elevated temperature, fracture at elevated temperature, high temperature alloys, effect of metallurgical variable creep under combined stresses.	6
5	**FATIGUE:** Introduction, stress cycle, the S-N curve, theories of fatigue, effect of stress concentration on fatigue, size effect, surface finish effect and fatigue, corrosion fatigue, effect of metallurgical variable on fatigue, effect of temperature on fatigue.	6
6	**CORROSION & CORROSION CONTROL:** Electrochemical and thermodynamics principles-Nernst equation and electrode potential of metals, standard electrodes and reference electrodes, E.M.F and galvanic series, effect of current density, polarization, Forms of corrosion-Atmospheric, pitting, stress corrosion cracking, intergrannular corrosion, corrosion fatigue, fretting corrosion, high temperature	6

	oxidation, crevice corrosion. Corrosion prevention by design improvement, coatings, cathodic and anodic protection, corrosion inhibitors.	
7	**CERAMIC MATERIALS:** Classification, Structure of ceramics, properties of ceramics, processing of ceramics, and discussion on specific ceramic materials	4
8	**POLYMERIC MATERIALS:** Introduction – as a material, Classification – types of polymerization, Mechanisms, Properties of polymers, properties of polymers, processing and application of polymers.	4
9	**FUNDAMENTAL ASPECTS OF COMPOSITE:** Introduction, classification of composites, historical background – micro – mechanics, inter-phase bond, stress distribution and load transfer, prediction of strength of composites, anisotropy and failure criteria; reinforcement materials, whiskers, inorganic fibbers, metal fibbers, glass fibers, resins, pultrusion process, structural composites.	6
10	**RECENT DEVELOPMENT:** Carbonaceous materials – including Nano tubes and fullerenes: shape memory alloys, functionally gradient materials; high temperature super conductors; bio materials – concept of bio compatibility – assessment – specific examples – bio electrodes, synthesis, characterization and applications of Nano materials.	4
11	**TESTING OF MATERIALS:** Destructive and non-destructive testing methods.	4

Practical content

Text Books	
1	Dieter G.E., 'Mechanical Metallurgy' 3rd Edition, Mc Graw Hill, 1988.
2	Dr.O.P.Khanna, "Material science and metallurgy", Dhanpat rai publications (P) Ltd.
Reference Books	
1	Reed-Hill R.E, 'Physical Metallurgy Principles', Affiliated East-West Press, 1977.
2	Avner S.H., 'Introduction to Physical Metallurgy', 2nd Edition, Mc Graw Hill, 1985.
3	Raghavan V, 'Physical Metallurgy', Prentice-Hall of India, 1985.
4	Fontana M. G, Greene N. D, 'Corrosion Engineering', 2nd Edition, McGraw Hill, 1978.
5	Hertzberg R. W, 'Deformation and Fracture Mechanics of Engineering Materials', 4th Edition, John Wiley, 1996.
6	Courtney T.H, 'Mechanical Behaviors of Materials', McGraw Hill, 1990.
7	Van Vlack, L.H, 'Physical Ceramics for Engineers', Addison Wesley, 1964.
Mooc Links:	
1	https://nptel.ac.in/courses/113/101/113101098/-Corrosion
2	https://nptel.ac.in/courses/113/104/113104096/-Properties of Material
3	https://nptel.ac.in/courses/113/106/113106093/-Nano Technology
4	https://nptel.ac.in/courses/113/106/113106088/ -Creep
5	https://nptel.ac.in/courses/112/106/112106293/-Material Science
6	https://nptel.ac.in/courses/112/104/112104249/-Composite

Course Outcomes:

After learning this course, the student would be able to:

1. Understand the phenomena of phase transformations and strengthening mechanisms.
2. Learn the basics of fracture, creep and fatigue.
3. Learn the fundamental about classification, processing, properties and applications of ceramic, polymer and composite materials.
4. Understand the basic principles of corrosion mechanism of metals in engineering applications.
5. Understand the basic principles of distractive and non-distractive methods.