

GANPAT UNIVERSITY									
FACULTY OF ENGINEERING AND TECHNOLOGY									
Programme		Master of Technology			Branch		Mechanical Engineering (Specialization in Additive Manufacturing)		
Semester		II			Version		1.0.0.0		
Effective from Academic Year			2025-26		Effective for the batch Admitted in			July 2025	
Subject code		3ME2117	Subject Name		Material Science in AM				
Teaching scheme					Examination scheme (Marks)				
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	2	0	5	Theory	40	60	100
Hours	3	0	4	0	7	Practical	60	40	100

Pre-requisites:
Fundamentals of metallurgy and material science, basic knowledge of additive manufacturing processes.

Course Learning Outcomes:
<p>The course content should be taught and implemented with an aim to develop different skills leading to the achievement of the following competencies and course learning outcomes:</p> <p>CO1: Explain the relationship between material structure, properties, and performance in AM processes.</p> <p>CO2: Analyze energy–material interactions in polymer, metal, ceramic, and composite AM systems.</p> <p>CO3: Evaluate the influence of AM process parameters on microstructure evolution and defects.</p> <p>CO4: Correlate microstructural characteristics with mechanical, thermal, and functional properties of AM parts.</p> <p>CO5: Assess material qualification, standards, and reliability aspects for industrial AM applications.</p>

Course Content		
Name of UNIT	Content	Hrs
UNIT – I: Metals, Polymers, and Composites for Additive Manufacturing	Metallic materials for AM: steels, aluminum alloys, titanium alloys, nickel-based superalloys; powder characteristics and requirements. Polymer materials for AM: thermoplastics, thermosets, elastomers, degradation and recyclability. Ceramic materials and ceramic-based systems. Composites and functionally graded materials for AM applications, material selection criteria for different AM processes.	8
UNIT – II: Solidification and Phase Transformation in Additive Manufacturing	Heat transfer and thermal cycles in AM, rapid solidification phenomena, melt pool dynamics, nucleation and grain growth, phase transformations under non-equilibrium conditions, microsegregation, residual stresses, influence of cooling rate and energy input on microstructure and properties.	10
UNIT – III: Defects, Porosity, and Anisotropy in AM Materials	Types of defects in AM: lack of fusion, keyhole porosity, gas porosity, cracking, delamination; anisotropy in mechanical and thermal properties, build orientation effects, process-induced residual stresses, defect mitigation strategies through process parameter control and material optimization.	8

UNIT – IV: Nano-materials and Functional Materials in Additive Manufacturing	Nano-materials for AM: nano-powders, nano-reinforcements, dispersion challenges; functional materials in AM including smart materials, bio-materials, shape memory alloys, electrically and thermally functional materials; applications in aerospace, biomedical, and electronics industries.	8
UNIT – V: Material Qualification and Standards	Material qualification requirements for AM, repeatability and reproducibility, mechanical and microstructural characterization, qualification of powders and feedstock, process–material qualification routes, international standards and certification frameworks (ASTM/ISO) for AM materials and components.	6

List of Practical

The practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate course learning outcomes.

No.	Unit	Name of Practical
1	1	Parameter optimization study on FDM or SLM systems.
2	2	Design and evaluation of support structures for complex geometries.
3	3	Mechanical testing and analysis of AM-fabricated components.
4	4	Dimensional accuracy and surface quality measurement of AM parts.
5	5	Topology optimization and redesign of a component for AM.
6	6	Case study analysis of an industrial AM application.

List of Instruments / Equipment / Trainer Board

1	Industrial or laboratory-scale AM systems (polymer and/or metal).
2	High-performance CAD/CAM workstations.
3	AM slicing and process planning software.
4	Simulation and optimization software for AM.
5	Mechanical testing and metrology equipment.

List of Reference Books

No.	Title of Reference Books	Authors	Publication
1	Additive Manufacturing of Metallic Materials	DebRoy, T., Wei, H. L., Zuback, J. S.	Springer
2	Laser Additive Manufacturing of High-Performance Materials	Gu, D.	Springer
3	Materials Science and Engineering: An Introduction	Callister, W. D., Rethwisch, D. G.	Wiley
4	Rapid Manufacturing: An Industrial Revolution for the Digital Age	Noorani R	John Wiley & Sons
5	Standards for Additive Manufacturing Materials and Processes.	ASTM International	CRC Press