

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		3ME2118		Subject Name		Additive Manufacturing for Medical Applications			
Teaching scheme									
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	2	0	2	0	4	Theory	40	60	100
Hours	2	0	4	0	6	Practical	60	40	100

Pre-requisites:
Basic knowledge of materials science, biomechanics, and fundamentals 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: Understand the role and scope of additive manufacturing in medical and healthcare applications.</p> <p>CO2: Analyze biomaterials used in medical additive manufacturing and their interaction with biological systems.</p> <p>CO3: Evaluate different AM processes for fabrication of medical devices and implants.</p> <p>CO4: Design patient-specific medical components using CAD and medical imaging data (CT/MRI).</p> <p>CO5: Assess regulatory standards, ethical issues, and quality assurance in medical AM products.</p>

Course Content		
Name of Unit	Content	Hrs
UNIT – I: Introduction to AM in Medical Applications	Overview of additive manufacturing technologies in healthcare. Evolution and current trends. Advantages of AM in medicine: customization, rapid prototyping, complex geometries. Medical device classification and requirements. Digital workflow for medical AM (CAD–imaging–printing).	8
UNIT – II: Biomaterials for Medical AM	Metallic biomaterials (Ti-6Al-4V, Co-Cr alloys, stainless steel), polymer biomaterials (PLA, PCL, PMMA, hydrogels), ceramic biomaterials (hydroxyapatite, bioglass). Biocompatibility, biodegradability, biofunctionality. Material selection criteria for medical AM.	10
UNIT – IV: Design and Modeling for Medical Applications	FDM/FFF, SLA, SLS, DMLS/SLM, EBM, Binder Jetting, Bioprinting. Process parameters and their effects on accuracy, surface finish, and mechanical properties. Post-processing: heat treatment, sterilization, surface coating, polishing.	8

UNIT – IV: Turbulence and Heat Transfer Modeling	Medical imaging (CT, MRI), segmentation and reconstruction. Conversion to 3D CAD models. Design of patient-specific implants and prosthetics. Lattice and porous structures for osseointegration. Simulation and validation of medical components.	8
UNIT – V: Regulations, Standards, and Case Studies	Regulatory frameworks (FDA, CE, ISO, ASTM). Quality control and validation. Ethical issues in medical AM. Case studies: orthopedic implants, dental prosthetics, cranial plates, surgical guides, anatomical models. Future trends in medical additive manufacturing.	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	Study of medical AM applications and digital workflow using case studies.
2	2	Material selection and basic characterization of biomaterials for AM.
3	3	Fabrication of a biomedical component using FDM/SLA printer.
4	4	Design of patient-specific implant using CT/MRI data.
5	5	Post-processing and surface finishing of medical AM parts.
6	5	Case study analysis of a commercial medical AM product.

List of Instruments / Equipment / Trainer Board

No.	Instruments / Equipment
1	Medical-grade or laboratory AM systems (polymer/metal).
2	High-performance CAD workstations.
3	Medical image processing and segmentation software (Mimics / 3D Slicer).
4	AM slicing and process planning software.
5	Mechanical testing and metrology equipment.

List of Reference Books

No.	Title of Reference Books	Authors	Publication
1	Additive Manufacturing in Medicine	Kun Zhou et al.	Springer
2	Medical Applications of 3D Printing	Francis R.	Elsevier
3	Biomaterials Science: An Introduction to Materials in Medicine	Ratner et al.	Academic Press
4	3D Printing and Additive Manufacturing Technologies	Gibson, Rosen, Stucker	Springer
5	Standards for Additive Manufacturing in Medical Devices	ASTM / ISO	CRC Press