

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Professional Elective –III: Additive Manufacturing
Course Code:	2ET1010705T
Pre-requisite Course:	Nil

Course Objectives:

1. To provide fundamentals of additive manufacturing (AM) with recent development and applications
2. To provide knowledge of different AM processes for various materials based on ASTM standards
3. To study role of CAD models and CAM programming in AM with Reverse engineering.
4. To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	3	-	-	3	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction: Overview – History – Need- Classification of AM processes- fundamental engineering aspects. Applications of AM: AM applications in various Industries. Industry 4.0 and Digital and Smart manufacturing.	04	10
2	Extrusion - Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, BioExtrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes. Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.	08	20
3	Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.	08	20
4	Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of nonequilibrium structure, microstructural studies, Structure property relationship.	08	20

5	Design For Additive Manufacturing: Core concepts and objectives, Principles of design for manufacturing and assembly, Constraint approach to design for additive manufacturing: Guidelines and rules for part building, Topology optimization and generative design, exploring design freedom, design tools.	04	10
6	Materials and Post Processing: Different materials used in AM- polymers, metals, multiple materials, multifunctional and graded materials. Tooling and Manufacturing: Classification of RT Routes, RP of Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirect method, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct method for Production Tooling.	04	10
7	Recent Trends in Additive Manufacturing: Composite 3D printing, Bio 3D printing of tissues and organs, Clay and Concrete 3D printing, 3D food printing, 3D printing in space, 4D printing.	04	10

Reference Books:

1. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, 2015.
3. C. P. Paul, A. N. Anoop, Additive Manufacturing – Principles, Technologies and Applications, Mc Graw Hill Education (I) Pvt. Ltd., 1st edition, 2021.
4. A. Bandyopadhyay and S. Bose, Additive Manufacturing, CRC Press, 2nd edition, 2015.
5. C.K. Chua, K.F. Leong and C.S. Lim, “Rapid prototyping: Principles and applications”, 3rd Edition, World Scientific.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_me122/preview

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand fundamentals of Additive manufacturing (AM) with classification of AM process.	1 Understanding
CLO2	Explain principle, and mechanism of solid based, liquid based and powder based additive manufacturing processes.	2 Understanding 3 Applying
CLO3	Select a suitable additive manufacturing process for a given material and application.	3 Applying
CLO4	Identify software related issues in additive manufacturing; and post processing aspects including defects and part quality.	3 Applying 4 Analyze
CLO5	Design and optimize a given part following guidelines and rules for part building.	4 Analyze 5 Evaluating
CLO6	Explain different materials used for building three dimensional AM components.	2 Understanding

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	H	L	–	–	–	–	–	–	–	–	–	L	M	L
CLO2	H	M	–	–	L	–	–	–	–	–	–	–	M	M
CLO3	M	H	M	–	M	–	–	–	–	–	–	–	H	H
CLO4	M	H	–	M	H	–	–	–	–	–	–	–	M	H
CLO5	M	M	H	–	M	–	–	–	–	–	–	–	H	H
CLO6	H	L	–	–	–	–	–	–	–	–				

H: High, M: Medium, L: Low