COURSE TITLE	**ADDITIVE MANUFACTURING**
COURSE CODE	**01CA1311**
COURSE CREDITS	**3**

Objective:

1 This module introduces Additive Manufacturing (AM) as a transformative prototyping and production strategy, distinguishing it from traditional subtractive and formative technologies. Students will master the workflow of processing CAD models for AM, applying fundamental techniques to navigate the transition from digital design to physical component. By selecting appropriate tooling and specialized AM processes, the course emphasizes the rapid development of prototypes and final products, ensuring that design requirements are met through efficient performance assessment. Ultimately, students will gain the expertise to leverage rapid prototyping as a convenient, modern solution for reconstructing complex engineering objects directly from digital data.

Course Outcomes: After completion of this course, student will be able to:

1 Analyze and evaluate research methodologies to independently investigate and solve practical engineering problems related to additive manufacturing.

2 Evaluate advanced concepts and techniques in additive manufacturing.

3 Apply modelling techniques to analyze additive manufacturing processes for achieving optimum part quality and performance.

4 Analyze and evaluate potential application areas in manufacturing industries where additive manufacturing can be effectively implemented.

5 Apply additive manufacturing techniques and evaluate their effectiveness across various industrial and engineering applications.

Pre-requisite of course: Computer Aided Design, Computer Aided Manufacturing

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	**Fundamentals Additive Manufacturing** Introduction: Prototyping, Traditional manufacturing as compared to Additive Manufacturing (AM), Need for time compression in product development, Principle, Patents, , File formats: CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, , Preparing model for Additive Manufacturing: Part orientation and support generation, Support structure design, Model Slicing and contour data organization, uniform and variable slicing, Tool path generation–G code, Various software used in AM – open-source, turnkey	6
2	**Additive Manufacturing Techniques** Photopolymerization: Process, materials, machine vendors and Techniques for Stereolithography (SLA), Direct Light Polymerization (DLP), Powder Bed Fusion: Process, materials, machine vendors and Techniques for Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, Selective Laser Melting (SLM), Electron Beam melting (EBM), Direct Metal Laser Sintering DMLS., Extrusion-Based AM Systems: Process, materials, machine vendors and Techniques for Fused Deposition Modeling (FDM), wire welding , Material Jetting: Process, materials, machines and Techniques for 3D printing (3DP), Multi Jet Printing (MJP), Sheet Lamination: Process, materials, machines and Techniques for Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding , Beam Deposition: Process, materials, machines and Techniques for Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD).	9
3	**Optimization and Troubleshooting in Additive Manufacturing** Pre-Processing: Optimally orienting a CAD model for part manufacturing, maximizing utilization of build volume, creating an error free STL file, Creating an error free G-code file, Part Building: General errors in various AM processes, Defects and troubleshooting – warpage, delamination, spatters, etc. Parameter setting, Parameter control Post-Processing, Removing support structure, finishing the part, coating techniques, coloring the part, realistic and aesthetic part making processes	9
4	**Additive Manufacturing Applications** Reverse Engineering (RE) methodologies and techniques, Selection of RE systems, RE software, RE hardware, Scanning a model, Data conversion, RE in product development., Conventional Tooling as compared to Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. Use of Rapid Tooling in Industries, Medical, dental and paramedical applications, Aerospace, Automotive, GIS, Jewellery making, Education	9

Contents : Unit	Topics	Contact Hours
5	**Design for Additive Manufacturing** Design Procedure, Topology Optimization, Material selection and use of in design, Design for AM, Economics in AM, Concepts of mass production and automation in AM, , ISO/TC 261 and ASTM F42 standards committee, Terminologies, Qualification guidance, Recommendations for materials, processes, system performance and finishing a part, Testing procedures, Inspection methods, Futuristic manufacturing: Safe and reliable application of AM, Ethical practices, Compatibility with Industry-4.0 – New age manufacturing, Sustainable manufacturing using AM, Manufacturing in space.	9
Total Hours		**42**

Textbook :

1 Rapid Prototyping: Principles and Applications in Manufacturing, 1. Chua C K, Leong K F, Chu S L, World Scientific, 2022

2 Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2. Gibson D W Rosen, Brent Stucker, Springer, 2022

References:

1 Rapid Prototyping: Principles and Applications in Manufacturing,, Rapid Prototyping: Principles and Applications in Manufacturing,, Noorani R,, John Wiley & Sons., 2015

2 Rapid Tooling: Technologies and Industrial Applications,, Rapid Tooling: Technologies and Industrial Applications,, Hilton P, Jacobs P F,, CRC Press, 2000

3 Rapid Prototyping and Engineering applications: A tool box for prototype development,, Rapid Prototyping and Engineering applications: A tool box for prototype development,, Liou W L, Liou F W,, CRC Press, 2009

4 Rapid Prototyping: Theory and practice,, Rapid Prototyping: Theory and practice,, Kamrani A K, Nasr E A,, Springer, 2010

5 Additive Manufacturing (Handbooks on Advanced Manufacturing), Additive Manufacturing (Handbooks on Advanced Manufacturing), j paulo davim, Elsevier, 2021

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	10.00	25.00	25.00	25.00	5.00

Instructional Method:

1 The knowledge given to students is in the form of videos, books and case studies

Supplementary Resources:

1 https://onlinecourses.nptel.ac.in/noc22_me130