



## FACULTY OF ENGINEERING & TECHNOLOGY

### First Year Master of Engineering

#### Semester II

**Course Code: 102320207**

**Course Title: Additive Manufacturing & Tooling**

**Type of Course: Program Elective IV**

**Course Objectives:** This course addresses the principle of various AM techniques and its concept, scope, building strategies, post-processing and areas of applications along with different rapid tooling methods and reverse engineering

#### Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Internal		External		Total
				Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	30 / 15	20 / 10	70 / 35	30 / 15	150 / 75

\* J: Jury; V: Viva; P: Practical

#### Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction: Traditional Prototyping Vs. Rapid Prototyping (RP), Classification of Rapid Manufacturing Processes: Additive, Subtractive, Formative, Generic RP process, STL file Generation, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength and its limitations.	4
2	CAD Modelling and Data Processing: CAD model preparation, Data interfacing: formats like STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP, conversation; Part orientation and support generation, Support structure design, direct and adaptive slicing, Tool path generation.	4
3	Liquid based systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, applications, advantages and disadvantages. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantage, Rapid Freeze Prototyping (RFP), Solid Object Ultraviolet-Laser Printer (SOUP) process & Two Laser Beams process.	6



4	Solid based systems: Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Benchtop System: Process, Working principle, Applications. Multi-Jet Modeling System.	6
5	Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, Electron Beam Melting (EBM): Process, Working principle, Applications, Laser Engineered Net Shaping (LENS) & Electron Beam Melting process	6
6	Rapid Tooling: Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling - Direct AIM, Quick cast process, Direct Metal Laser Sintering Tooling (DMLS) Rapid Tool, ProMetal, Laminate tooling, soft tooling vs hard tooling.	6
7	Reverse Engineering: Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems	2
8	Errors in AM Processes: Pre-processing, processing, post-processing errors, Part building errors in different additive manufacturing processes	3
9	Additive Manufacturing Applications: Design, Engineering Analysis and planning applications, Medical Applications of RP, Forensic Science and Anthropology, Arts and Architecture, Aerospace Industry, Automotive Industry, Jewellery Industry, Coin Industry etc.	2

### Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						R: Remembering; U: Understanding; A: Application, N: Analyze; E: Evaluate; C: Create
R	U	A	N	E	C	
10	10	30	20	20	10	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Books:

1	Rapid Prototyping: A Brief Introduction, Ghosh A., Affiliated East West
2	Rapid Prototyping Technology: Selection and Application, Kenneth G. Cooper, CRC Press
3	Rapid Prototyping: Principles and Applications, Chua Chee Kai, Leong Kah Fai, Lim Chu -Sing, World Scientific
4	Rapid Prototyping theory & practice, Ali K. Kamarani, Manufacturing System Engineering Series, Springer Verlag
5	Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Gibson I, Rosen D W., and Stucker B, Springer



6	Rapid Prototyping: Principles and Applications in Manufacturing, Noorani R, John Wiley & Sons
7	Rapid Tooling: Technologies and Industrial Applications, Hilton P, Jacobs P F, CRC press

### Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Acquire knowledge about the fundamentals for additive manufacturing with compare to traditional manufacturing	10
CO-2	Understand and use techniques for processing of CAD models for rapid Prototyping	15
CO-3	Understand the operating principles, capabilities, and limitations of liquid based, solid based & powder based additive manufacturing system	50
CO-4	Apply the proper tooling methods for rapid prototyping process.	15
CO-5	Discover the rapid prototyping techniques for reverse engineering with different applications	10

### List of Practicals / Tutorials:

1	Introduction to different additive manufacturing processes
2	Study of different data formats
3	Generating STL files from the CAD Models & Working on STL files
4	Study of Slicing Strategies
5	Prepare a CAD model with complex geometry and study effect of slicing parameters on final product manufactured through RP
6	Study & explore Liquid based additive manufacturing system
7	Study & explore solid based additive manufacturing system
8	Study & explore powder based additive manufacturing system
9	Rapid tooling: future of tooling
10	Role of reverse engineering in additive manufacturing systems
11	Applications of additive manufacturing systems with case study

### Supplementary learning Material:

1	<a href="https://nptel.ac.in/courses/112/104/112104265">https://nptel.ac.in/courses/112/104/112104265</a>
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### Curriculum Revision:

Version:	1
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22