

## MFPC3004 RAPID MANUFACTURING PROCESSES (3-0-0)

### Course Objective:

The course on Rapid Manufacturing Processes (RMP) aims to provide students with fundamental and advanced knowledge of modern manufacturing methods with a focus on rapid prototyping (RP), additive manufacturing (AM), and tool-free production systems. This course intends to bridge the gap between design and manufacturing by enabling faster product development cycles.

Students will explore various rapid manufacturing technologies, materials used, file preparation techniques, post-processing methods, and applications of RMP in engineering and biomedical fields. The course also emphasizes the comparison between conventional and rapid techniques, highlighting the advantages, limitations, and suitability of each method in specific scenarios.

By the end of the course, students will be trained to identify, select, and analyze appropriate rapid manufacturing processes for different industrial applications, enabling them to contribute innovatively to product development and prototype making.

### Module 1: Introduction to Rapid Manufacturing and Prototyping

The basics of rapid manufacturing, the evolution of prototyping methods, and the importance of additive processes in design validation and product development. Subtractive and additive manufacturing, introduces terminology, and outlines the steps from concept to prototype.

Introduction to Rapid Prototyping and Manufacturing (RPM)

Need for rapid product development

Process chain in additive manufacturing

Comparison with traditional manufacturing methods

Classification of RP processes

### Module 2: Additive Manufacturing Technologies

Detailed study of major additive manufacturing technologies. Working principle, process parameters, advantages, limitations, and application areas for each process.

Stereolithography (SLA)

Fused Deposition Modeling (FDM)

Selective Laser Sintering (SLS)

Laminated Object Manufacturing (LOM)

Electron Beam Melting (EBM)

Binder Jetting and PolyJet Printing

Process comparison and selection

### Module 3: CAD Modeling, Reverse Engineering, and Data Handling

Data preparation and input required for RP systems. Uses of 3D CAD models, slicing and conversion of 3D CAD models into machine-readable formats, and support of reverse engineering for rapid manufacturing process.

CAD model creation requirements for Additive Manufacturing (AM)

STL file format and limitations

Model slicing and support generation

Reverse engineering and 3D scanning

File repair and data exchange

### Module 4: Materials for Rapid Manufacturing and Post-Processing

Various materials used in rapid manufacturing processes, including plastics, metals, ceramics, and composites. Use of post-processing to improve surface finish, strength, and dimensional accuracy.

Thermoplastics, photopolymers, and metal powders

Ceramic and bio-compatible materials

Material suitability for each AM process  
Secondary processes: curing, machining, surface finishing  
Part accuracy and mechanical properties

**Module 5: Applications, Limitations, and Emerging Trends**

Application of rapid manufacturing methods across industries such as automotive, aerospace, biomedical, and consumer goods. Current trends and limitations such as process speed, material constraints, cost, and sustainability.  
Applications in product design and development  
RP for tooling: Room Temperature Vulcanization (RTV), vacuum casting, soft tooling  
Biomedical and dental applications  
Limitations and challenges in RMP  
Future trends: 4D printing, hybrid manufacturing

**Course Outcomes (COs):** Upon successful completion of this course, students will be able to:

- CO1 Understand the fundamentals of Rapid Manufacturing and the need for rapid prototyping and additive manufacturing in today's product development cycle.
- CO2 Classify and describe various Rapid Prototyping (RP) technologies and explain the working principles of key additive manufacturing processes.
- CO3 Analyze the materials used in rapid manufacturing processes and explain the significance of preprocessing (CAD model preparation) and post-processing techniques.
- CO4 Evaluate the process capabilities, accuracy, limitations, and economic implications of various rapid manufacturing technologies.
- CO5 Apply rapid manufacturing techniques in real-world applications including product design, reverse engineering, tooling, biomedical components, and customized manufacturing.

**Textbooks:**

1. Chua C.K., Leong K.F., and Lim C.S. – Rapid Prototyping: Principles and Applications, World Scientific Publishing.
2. Pham D.T., and Dimov S.S. – Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer.

**Reference Books:**

1. Gibson, I., Rosen, D.W., and Stucker, B. – Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
2. Kamrani, A.K., and Nasr, E.A. – Rapid Prototyping: Theory and Practice, Springer.
3. ASTM F42 Committee – Standards for Additive Manufacturing.