

## Additive Manufacturing and 3D Printing

### Course general description:

Additive manufacturing (AM), commonly known as 3D printing, has revolutionized the way products are designed, prototyped, and manufactured. This course provides a comprehensive exploration of the fundamental principles, technologies, and applications of 3D printing across various industries. Participants will gain hands-on experience with different 3D printing techniques, learn how to optimize designs for additive manufacturing, and explore its role in prototyping, production, and innovation. By the end of the course, participants will be equipped to leverage 3D printing for engineering systems and product development.

### Audience:

This course is designed for:

1. Engineers and designers involved in product development and manufacturing.
2. Prototyping specialists and R&D professionals.
3. Entrepreneurs and innovators exploring 3D printing for business applications.
4. Academics and students in mechanical, industrial, and manufacturing engineering fields.

### Course objectives:

By end of the course participants will gain:

1. Understand the fundamental principles and processes of additive manufacturing.
2. Learn about the different 3D printing technologies and their applications.
3. Gain skills in designing for additive manufacturing (DfAM) and optimizing part geometry.
4. Explore the use of 3D printing in prototyping, tooling, and end-use production.
5. Develop problem-solving skills through practical exercises and case studies.
6. Gain awareness of advancements in materials, software, and industry trends.

### Course duration:

5 days

### Course location:

Cairo-Dubai-Istanbul

### Course contents:

#### **Day 1: Introduction to Additive Manufacturing and 3D Printing**

- Fundamentals of Additive Manufacturing – Differences from traditional manufacturing, key principles, and historical evolution.
- Types of 3D Printing Technologies – Overview of FDM, SLA, SLS, and metal 3D printing (DMLS, EBM).
- Emerging Technologies – Binder jetting, material jetting, and advancements in 3D printing methods.
- Challenges and Opportunities – Adoption barriers, design flexibility, and industrial applications.
- Case Study & Pretest – Assess knowledge, discuss industry trends, and analyze aerospace prototyping.

#### **Day 2: Design for Additive Manufacturing (DfAM)**

- Key Design Principles – Overhangs, supports, topology optimization, and generative design.
- Benefits of DfAM – Lightweight structures, complex geometries, and material efficiency.
- Software Tools – CAD modeling (SolidWorks, Fusion 360), slicing software (Cura, PrusaSlicer), and simulation tools.
- Practical Exercises – Create, slice, and optimize a 3D model for printing.

- Quiz & Discussion – Assess understanding of design principles and software applications.

### **Day 3: Materials and Applications in 3D Printing**

- 3D Printing Materials – Polymers (PLA, ABS), metals (titanium, stainless steel), and composites.
- Industrial Applications – Automotive, aerospace, consumer goods, and medical devices.
- End-Use Parts and Prototyping – Functional prototypes, tooling, and production components.
- Material Selection Challenges – Strength, durability, and cost considerations.
- Case Study & Quiz – Analyze metal 3D printing for medical implants and test material knowledge.

### **Day 4: Prototyping, Production, and Post-Processing**

- Rapid Prototyping Workflows – Iterative design, functional vs. visual prototypes, and cost/time savings.
- Scaling to Production – Transitioning to low-volume and mass production.
- Post-Processing Techniques – Sanding, polishing, heat treatment, and quality control.
- Hands-On Printing – Create a functional prototype using an FDM printer.
- Group Activity – Develop a post-processing plan for a 3D-printed part.

### **Day 5: Advancements and Final Assessment**

- Innovations in 3D Printing – Multi-material printing, AI integration, and energy-efficient processes.
- Future Trends – Bioprinting, construction 3D printing, and space manufacturing.
- Career Pathways – Professional opportunities, entrepreneurship, and industry advancements.
- Final Assessment – Comprehensive written test and comparison with pretest results.
- Feedback & Discussion – Key takeaways, participant questions, and course reflection.

### **Methodology:**

- 50% lectures & concepts
- 10% Videos
- 15% Case studies
- 15% Exercises
- 10% Discussions

**Course code: (TGRL004)**