



SNS College of Technology, Coimbatore-35.
(Autonomous)

B.E/B.Tech- Internal Assessment -I
Academic Year 2023-2024 (Odd)

Fifth Semester

Automobile Engineering

19AUT303 - Additive Manufacturing and its applications - Answer Key



Time: 1^{1/2} Hours

Maximum Marks: 50

Answer All Questions

PART - A (5 x 2 = 10 Marks)

1. Define Additive Manufacturing

Additive Manufacturing (AM), also known as 3D printing, is a manufacturing process that builds three-dimensional objects by adding material layer by layer. In contrast to traditional subtractive manufacturing processes (such as machining or cutting), where material is removed from a solid block to create a final product, additive manufacturing builds the object from the ground up.

2. Write short notes on Manufacturing Process

Manufacturing processes are essential for transforming raw materials or components into finished products. These processes can vary widely based on the type of product being made and the materials used.

3. Distinguish between Additive and Conventional Manufacturing processes

S. No	Additive Manufacturing	Subtractive Manufacturing
a.	In additive manufacturing, layer by layer material is added one over another to develop desired solid 3-D product.	In subtractive manufacturing, layer by layer material is gradually removed from a solid block to fabricate 3-D product.
b.	This manufacturing concept is usually suitable for materials having low melting point, such as plastic.	This manufacturing concept can be applied to all solid materials irrespective of melting point.
c.	Volumetric density (thus weight) of the constructive material of final component can be controlled during operation.	Material density cannot be controlled during operation. Density of object remains same with that of the initial solid block (usually a cast product).
d.	No material wastage takes place in these processes.	These processes are associated with material wastage in the form of chips, scraps, dissolved ions, vapors, etc.

4. What is part orientation in 3D printing?

Part orientation is a critical aspect of 3D printing that involves choosing the best way to position a 3D model within the printer's build volume to achieve desired results in terms of quality, strength, and efficiency. It requires careful consideration of various factors to optimize the printing process and ensure the successful creation of 3D-printed objects.

5. What is support structure in additive manufacturing?

Support structures are an essential component of additive manufacturing because they make it feasible to produce detailed and complicated designs that would otherwise be difficult or impossible to make. They may complicate the printing process a little, but they are an important tool for producing detailed 3D prints of the highest calibre.

PART – B (40 Marks)

6. (a) Distinguish between 2D and 3D Modelling softwares with relevant examples.

2D and 3D modeling software are both used in various fields such as engineering, architecture, animation, and graphic design, but they serve different purposes and have different functionalities. Here are the key distinctions between the two:

2D Modeling Software:

2D modeling software is used for creating flat, two-dimensional images and designs. It is widely used for creating illustrations, technical drawings, and graphic designs.

Functionality: It focuses on creating shapes, lines, and text in two-dimensional space. It does not have the ability to create three-dimensional objects or models.

Examples: Some well-known 2D modeling software includes Adobe Illustrator, CorelDRAW, Inkscape, and Autodesk Sketchbook. These tools are used for creating logos, brochures, posters, and other types of graphical designs that do not require a third dimension.

3D Modeling Software:

3D modeling software is used for creating three-dimensional models that can be used for rendering, animation, and manufacturing purposes. It allows the creation of complex 3D objects with depth and realism.

Functionality: It enables users to create, modify, and visualize 3D objects and scenes. It is widely used in industries such as video game development, architecture, product design, and animation.

Examples: Popular 3D modeling software includes Autodesk Maya, Autodesk 3ds Max, Blender, and SketchUp. These tools are used for creating 3D models of characters, environments, products, and architectural designs.

(or)

6. (b) Classify the 3D Printing technology and explain in detail about its applications on various fields of Engineering

3D printing, also known as additive manufacturing, has advanced rapidly in recent years and has found numerous applications in various fields of engineering. There are several types of 3D printing technologies, each with its unique features and applications.

Stereolithography (SLA): This technique uses a UV laser to solidify a liquid resin, layer by layer, creating a 3D object.

Fused Deposition Modeling (FDM): FDM technology melts and extrudes thermoplastic filament through a nozzle to create layers of the object.

Selective Laser Sintering (SLS): SLS employs a high-powered laser to fuse small particles of plastic, metal, ceramic, or glass powders into a 3D object.

Digital Light Processing (DLP): DLP works similarly to SLA but uses a digital light projector to flash a single image of each layer across the entire platform at once.

Selective Laser Melting (SLM): SLM is primarily used for creating metal parts by selectively melting metal powder using a high-powered laser.

Electron Beam Melting (EBM): EBM uses an electron beam to melt and fuse metal powder to create 3D metal objects.

Applications of 3D printing in various fields of engineering include:

Aerospace Engineering: 3D printing is used for rapid prototyping of components, lightweight structural parts, and complex geometries, leading to reduced weight and enhanced fuel efficiency.

Automotive Engineering: It is used for creating custom parts, prototypes, and tooling, leading to faster design iterations and reduced production costs.

Biomedical Engineering: 3D printing aids in the production of patient-specific implants, prosthetics, and medical devices, leading to better treatment outcomes and personalized healthcare solutions.

Civil Engineering and Architecture: It is used for creating detailed architectural models, intricate designs, and complex structures, allowing architects and engineers to visualize and communicate their ideas effectively.

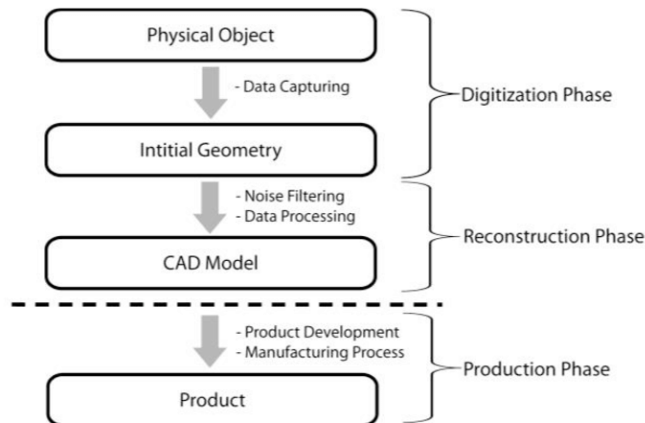
Mechanical Engineering: 3D printing is used for manufacturing complex parts, tooling, and prototypes, leading to improved design verification and faster product development cycles.

Electrical Engineering: It aids in the fabrication of custom electronic components, circuit boards, and

intricate designs, leading to the development of innovative electronic devices.

Environmental Engineering: 3D printing is used to create models for urban planning, environmental monitoring equipment, and sustainable infrastructure designs.

7. (a) Explain the steps in Reverse Engineering in detail.



Reverse engineering is the process of analyzing a product, device, or system to understand its structure, functionality, and operation. It involves systematically dismantling and examining the components of an object to understand how it works, with the goal of recreating, replicating, or improving upon the original design. The steps involved in reverse engineering typically include the following:

Planning and Goal Setting:

Define the objectives of the reverse engineering process. Determine the specific goals, such as understanding the functionality, improving the design, or replicating the product.

Acquisition of the Object:

Obtain the physical object or product to be reverse engineered. This could involve purchasing the product or obtaining it through other means, such as borrowing or leasing.

Disassembly and Examination:

Carefully disassemble the product into its individual components, documenting each step and taking notes or photographs to ensure that the reassembly process is accurate. Use appropriate tools to avoid damage to the components.

Component Analysis:

Analyze each component's materials, dimensions, and manufacturing methods. This step involves studying the properties, specifications, and tolerances of the materials used in the original product.

Functional Analysis:

Understand the function and interaction of each component within the product. Identify the connections, mechanisms, and interfaces between different parts to comprehend the overall functionality of the product.

3D Scanning or Imaging:

Use 3D scanning techniques, such as laser scanning or structured light scanning, to capture the geometry and dimensions of the components. This step helps in creating accurate digital models of the object for further analysis and modification.

Reverse Engineering Software:

Utilize specialized software to convert the collected data into a digital model. Use Computer-Aided

Design (CAD) software to create a 3D model of the object based on the collected data and measurements.

Redesign and Modification:

Make any necessary modifications or improvements to the design based on the analysis and findings. This step involves using the 3D model to make changes that enhance the performance, efficiency, or manufacturability of the product.

Prototype Development:

Create a prototype based on the modified design. This step allows for testing and validation of the redesigned product to ensure that it meets the desired specifications and performance requirements.

Testing and Validation:

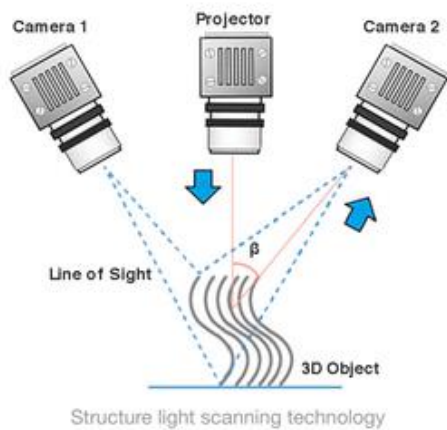
Test the prototype to verify that it functions as intended. Conduct various tests to ensure that the redesigned product meets the required standards and performs as expected.

Documentation and Reporting:

Document the entire reverse engineering process, including the steps taken, data collected, modifications made, and test results. Prepare a comprehensive report that outlines the findings, insights, and recommendations for future development or improvement.

7. (b) Illustrate 3D Scanning Digitization techniques

There are several techniques for 3D scanning and digitization that are commonly used in various industries. These techniques allow for the capture of physical objects and environments in three-dimensional digital formats.

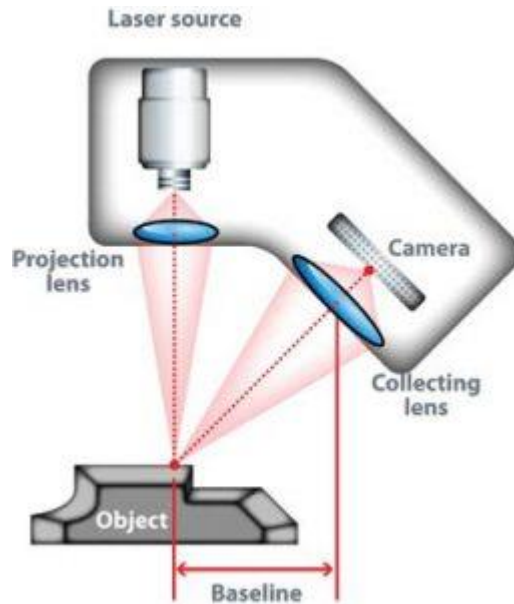


Structured Light Scanning:

This method involves projecting a series of light patterns onto the surface of an object. The deformation of these patterns on the object's surface is then captured by cameras, allowing for the reconstruction of the object's 3D surface geometry. Structured light scanning is often used for capturing small to medium-sized objects with high precision.

Photogrammetry:

Photogrammetry involves capturing multiple 2D images of an object or an environment from different angles. These images are then processed using specialized software to reconstruct the 3D structure of the object or the environment. Photogrammetry can be used with regular cameras or specialized rigs, and it is often utilized for large-scale 3D modeling, such as in the film and video game industries.



Laser Triangulation:

Laser triangulation scanners use a laser line to sweep across the surface of an object. A camera then captures the deformation of this laser line, allowing for the calculation of the object's 3D shape. This technique is commonly used for high-speed scanning of objects and is often employed in industrial applications.

6. (a) Discuss in detail about the applications of 3D printing technology for real time applications with suitable examples

3D printing technology, also known as additive manufacturing, has revolutionized various industries by enabling the production of complex, customized, and intricate designs. Its applications span across multiple fields, ranging from healthcare and aerospace to automotive and consumer goods.

Healthcare:

Prosthetics and Orthotics: 3D printing allows for the creation of customized prosthetic limbs and orthotic devices tailored to the specific needs of patients. Companies like Open Bionics are using 3D printing to produce affordable and customizable prosthetic limbs for amputees.

Surgical Tools and Implants: Customized surgical tools and implants, such as bone implants and patient-specific surgical guides, can be manufactured using 3D printing. For example, the company 3D Systems has developed 3D-printed surgical models to aid in complex surgeries.

Aerospace:

Prototyping and Manufacturing of Components: Aerospace companies utilize 3D printing for rapid prototyping and the production of complex components, leading to reduced lead times and costs. For instance, Airbus has incorporated 3D-printed components in its A350 XWB aircraft, including brackets and other structural elements.

Engine Parts: Some aircraft engine manufacturers use 3D printing to produce intricate and lightweight

components, leading to improved fuel efficiency. General Electric (GE) has used 3D printing to manufacture fuel nozzles for its LEAP engines.

Automotive:

Prototyping and Customization: Automotive companies leverage 3D printing for rapid prototyping of parts, enabling faster design iterations and reducing development costs. Companies like Ford and BMW have integrated 3D printing into their prototyping and manufacturing processes.

Spare Parts Production: 3D printing facilitates on-demand production of spare parts, reducing inventory costs and lead times. For instance, Bugatti has used 3D printing to produce various components for its high-performance cars.

Consumer Goods:

Customized Products: 3D printing enables the creation of personalized consumer goods, such as custom-designed jewelry, phone cases, and household items. Companies like Shape ways offer a platform for users to create and order customized 3D-printed products.

Fashion and Wearables: Some fashion designers use 3D printing to produce avant-garde and intricate wearable designs, pushing the boundaries of traditional fashion. For example, Iris van Herpen has showcased 3D-printed dresses in her collections.

8. (b) Mention the software packages available for 3D solid Modeling and their role in Rapid Prototyping

Several software packages are available for 3D solid modeling, each offering a range of features and capabilities that cater to different user needs and applications. These software packages play a crucial role in the rapid prototyping process by enabling engineers, designers, and manufacturers to create detailed 3D models efficiently.

Autodesk Fusion 360:

Role in Rapid Prototyping: Fusion 360 is a versatile software that allows users to create 3D models, perform simulations, and generate toolpaths for rapid prototyping and manufacturing. It facilitates the seamless transition from design to prototyping by providing integrated CAD, CAM, and CAE tools in a single platform.

SolidWorks:

Role in Rapid Prototyping: SolidWorks is widely used for 3D solid modeling, simulation, and product data management. It aids in the rapid prototyping process by enabling the creation of detailed 3D models, which can be easily exported for 3D printing. Its simulation capabilities help engineers test the performance of prototypes before physical production.

AutoCAD:

Role in Rapid Prototyping: AutoCAD is a widely used software for 2D and 3D computer-aided design. It allows users to create precise and detailed 3D models, which can be exported for rapid prototyping and additive manufacturing. AutoCAD's comprehensive tools enable efficient design creation and modification for rapid prototyping purposes.

SOLIDWORKS 3D CAD:

Role in Rapid Prototyping: SOLIDWORKS 3D CAD provides advanced solid modeling capabilities that aid in the rapid prototyping process. It enables the creation of complex 3D models, assemblies, and drawings, allowing users to visualize and validate designs before moving on to the prototyping phase.

Tinkercad:

Role in Rapid Prototyping: Tinkercad is a user-friendly, web-based 3D modeling software that is commonly used for rapid prototyping, especially in educational settings and for hobbyists. It enables users to create basic 3D models and export them for 3D printing, making it an accessible option for those new to 3D modeling and printing.

These software packages streamline the design and modeling process, facilitating the creation of intricate 3D models that can be quickly translated into physical prototypes using various rapid prototyping technologies such as 3D printing, CNC machining, and injection molding. They play a crucial role in reducing the time and costs associated with traditional prototyping methods, ultimately accelerating product development cycles.