<u>Minor Degree in Additive Manufacturing –</u>

Sl No	Course code	Course	L	T	P	Credit
1	MINOR301M	Introduction to additive manufacturing	3	0	0	3
2	MINOR401M	Design for Additive Manufacturing	3	0	2	4
3	MINOR501M	3D printing and prototyping	2	0	2	3
4	MINOR601M	Material, Processing & Application of 3D Printing	4	0	0	4
5	MINOR701M	3D Metal Printing	3	0	0	3
6	MINOR801M	3D Printing Project	0	0	6	3

Course Name: Introduction to Additive Manufacturing

Course Code: MINOR301M

Credits: 3 (L3-T0-P0)

Course Objectives

- To introduce the fundamental concepts, evolution, and classifications of Additive Manufacturing (AM).
- To understand major AM processes, their parameters, and industrial applications.
- To explain data preparation, STL handling, and workflow in AM.
- To explore post-processing and applications of AM in various sectors.

Detailed Syllabus

UNIT 1 – Fundamentals of Additive Manufacturing (6 Hours)

Overview of AM systems; classification of AM processes; evolution and importance of AM; AM process chain; advantages and limitations; applications in modern production.

UNIT 2 – Additive Manufacturing Processes (10 Hours)

Detailed study of major AM techniques:
SLA, FDM, LOM, SDL, Z-Corp 3D printing, SLS, SLM, LENS, and EBM.
Principles of operation, materials used, process parameters, resolution, build rate, accuracy, advantages, and limitations.

UNIT 3 – Data Preparation and STL Handling (7 Hours)

CAD model preparation; tessellation; STL file format; common STL errors (holes, inverted normals, missing facets); file repair and validation; slicing algorithms; adaptive slicing.

UNIT 4 – Post-Processing in Additive Manufacturing (7 Hours)

Post-curing, surface finishing, infiltration, heat treatment, machining, and rapid tooling techniques (RTV molding, vacuum casting, electroforming).

UNIT 5 – Applications of Additive Manufacturing (6 Hours)

Applications in aerospace, automotive, biomedical, and consumer industries; product customization; rapid tooling; repair and maintenance; sustainability and future trends in AM.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain the fundamentals and classifications of various Additive Manufacturing (AM) technologies.
CO2: Describe the working principles, capabilities, limitations, and applications of major AM processes.
CO3: Analyze STL handling, slicing, and process parameters to identify and troubleshoot AM workflow issues.
CO4: Select appropriate AM technologies and materials for specific industrial and product applications.

Textbooks

1. Gibson, I., Rosen, D.W., and Stucker, B., Additive Manufacturing Technologies, Springer, 2021.
2. Chua, C.K., Leong, K.F., and Lim, C.S., Rapid Prototyping: Principles and Applications, World Scientific, 2020.

Reference Books

1. Gebhardt, A., Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser, 2021.
2. Bandyopadhyay, A., and Bose, S., Additive Manufacturing, CRC Press, 2019.
3. Olaf Diegel, A Practical Guide to Design for Additive Manufacturing, Springer, 2019.
4. Martin Leary, Design for Additive Manufacturing, Elsevier, 2019.
5. Ben Redwood, The 3D Printing Handbook: Technologies, Design and Applications, 3D Hubs, 2017.
6. Pham, D.T. and Dimov, S.S., Rapid Manufacturing, Springer, 2001.
7. Frank W. Liou, Rapid Prototyping and Engineering Applications, CRC Press, 2011.

Coursera/NPTEL Mapping:

1	Introduction to Additive Manufacturing Processes	https://www.coursera.org/learn/introduction-to-additive-manufacturing-processes
2	The 3D Printing Revolution	https://www.coursera.org/programs/iem-uem-program-2024-2dvv9/learn/3d-printing-revolution?source=search
3	3D Printing and Additive Manufacturing Specialization	https://www.coursera.org/programs/iem-uem-program-2024-2dvv9/specializations/3d-printing-additive-manufacturing?source=search
4	Fundamentals of Additive Manufacturing Technologies	https://onlinecourses.nptel.ac.in/noc22_me122/preview

Course Name: Design for Additive Manufacturing

Course Code: MINOR401M

(3-0-2), Credits: 4

Course Objectives

- To develop proficiency in 3D CAD modeling techniques specific to additive manufacturing.
- To learn reverse engineering and data digitization techniques for AM part design.
- To understand AM data formats (STL, AMF, 3MF) and error correction procedures.
- To apply pre-processing and simulation tools for design optimization in AM.
- To design parts suitable for metal and polymer AM processes considering structural and process limitations.

Detailed Syllabus

UNIT 1 – Design of Solids and CAD Data for AM (8 Hours)

3D modeling for AM: parametric and mesh modeling, Boolean operations, surface and solid modeling (B-rep, CSG), and geometric transformations.
Advanced modeling methods: CAD data exchange formats (AMF, 3MF, XML, PLY, STEP, APs).
Finite element simulation of additive process; prototyping and iterative design workflow.
Overview of 3D CAD software for AM – Fusion 360, Rhino, SolidWorks, Magics.
Design principles for AM parts including weight reduction, part consolidation, and design optimization.

UNIT 2 – Design Considerations for Metal and Polymer AM (7 Hours)

Metal AM:
Designing for Metal Powder Bed Fusion (PBF) – powder production, morphology, and size distribution; potential defects and mitigation; topology optimization; lattice structures; overhang and support considerations; residual stress reduction and part positioning guidelines.

Polymer AM:
Design for Material Extrusion, Vat Photopolymerization, and Polymer PBF.

Design considerations due to anisotropy, wall thickness, overhangs, support structures, and intricate features.

UNIT 3 – AM Data Formats and Mesh Processing (8 Hours)

STL and AMF data formats: tessellation accuracy, file diagnostics, and repair.
STL file issues (holes, inverted normals, non-manifold edges); mesh refinement and subdivision; optimization and validation algorithms.
Slicing methods, support generation, contour data organization, adaptive slicing, and toolpath generation.
Modeling of AM process parameters: build orientation, surface roughness (staircase effect), fabrication time, and cost optimization.

UNIT 4 – Reverse Engineering and Digitization (6 Hours)

Principles of reverse engineering; 3D scanning techniques (structured light, CT, laser).
Point cloud generation and processing; mesh reconstruction and surface fitting; STL file creation from scanned data.
Integration of scanned geometry with CAD systems; hybrid modeling workflows for design modification.

UNIT 5 – AM Software Workflow and Design Simulation (7 Hours)

Pre-processing and slicing using Magics, MeshLab, Rhino, and Fusion 360.
Support design and orientation optimization; parameter setup for build simulation.
Design optimization through topology and lattice structure generation.
Case studies: design modification for lightweight components and functional integration in AM.

Laboratory Experiments (Practical Component)

1. 3D modeling and assembly creation using CAD tools.
2. Generation of STL and AMF files for complex parts.
3. Detection and repair of STL errors using dedicated software tools.
4. Slicing and support structure generation using Magics or equivalent.
5. Study of the effect of build orientation on part accuracy and surface quality.
6. Simulation of AM build processes and estimation of build time.
7. Topology optimization for lightweight and high-strength design.
8. Reverse engineering of a sample component using 3D scanning and digitization.

Laboratory Outcome:
Students will be able to generate CAD models, perform slicing and process simulation, repair mesh files, and optimize designs for AM fabrication.

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Develop 3D CAD models using AM-oriented design principles and solid modeling techniques (B-rep, CSG).
CO2: Apply reverse engineering and 3D scanning for part digitization and mesh generation.
CO3: Identify and correct STL/AMF file errors and prepare accurate data for AM processing.
CO4: Utilize AM software tools for slicing, support generation, and build simulation to optimize design performance.

Textbooks

1. Mortenson, M.E., Geometric Modeling, Wiley, 2017.
2. Zeid, I., CAD/CAM: Theory and Practice, Tata McGraw-Hill, 2018.
3. Leary, M., Design for Additive Manufacturing, Elsevier, 2019.

Reference Books

1. Kamrani, A.K. and Nasr, E.A., Engineering Design and Rapid Prototyping, Springer, 2010.
2. Diegel, O., A Practical Guide to Design for Additive Manufacturing, Springer, 2019.
3. Saxena, A. and Sahay, B., Computer-Aided Engineering Design, Springer, 2005.
4. Rao, P.N., CAD/CAM: Principles and Applications, Tata McGraw-Hill, 2017.
5. Groover, M.P. and Zimmers, E.W. Jr., CAD/CAM: Computer-Aided Design and Manufacturing, Prentice Hall India, 2008.
6. Belegundu, A.D. and Chandrupatla, T.R., Introduction to Finite Elements in Engineering, Pearson, 2012.
7. Hutton, D.V., Fundamentals of Finite Element Analysis, McGraw Hill, 2017.

Coursera/NPTEL course Mapping:

1	3D Printing Software	https://www.coursera.org/learn/3d-printing-software
2	Design for Additive Manufacturing	https://www.coursera.org/learn/design-for-additive-manufacturing
3	3D Modeling for 3D Printing and Laser Cutting on Fusion 360	https://www.coursera.org/learn/packt-3d-modeling-for-3d-printing-and-laser-cutting-on-fusion-360-n8yrm
4	Introduction to 3D Modeling	https://www.coursera.org/learn/introduction-to-3d-modeling
5	3D Printing and Design for Educators	https://onlinecourses.swayam2.ac.in/ntr24_ed17/preview

Subject Name: 3D Printing and Prototyping

Subject Code: MINOR501M

Credits: 3 (L2-T0-P2)

Course Objectives

- To understand pre-processing and model preparation steps essential for additive manufacturing.
- To study the working principles and operation of various 3D printing processes and equipment.
- To evaluate the effects of key process parameters on printed part quality and performance.
- To perform hands-on experiments in 3D printing, post-processing, and quality assessment.

Detailed Syllabus

UNIT 1 – Pre-Processing in Additive Manufacturing (8 Hours)

Overview of 3D model preparation: CAD data formats (STL, AMF, 3MF), data translation, and prevention of data loss.
STL validation, error detection and repair (holes, inverted normals, and non-manifold edges).
Part orientation, slicing, support generation, and G-code generation.
Toolpath generation strategies; introduction to adaptive slicing and hatching patterns.
Reverse engineering and reconstruction of 3D-CAD models from scanned data. surface preparation of materials before and after printing.

UNIT 2 – 3D Printing Processes and Machines (8 Hours)

Fundamentals, working principles, and setup of FDM, SLA, DLP, and SLS systems.
Material selection: polymers, resins, powders, and composites.
Machine calibration, parameter optimization (speed, temperature, infill, layer height), and troubleshooting.
Overview of popular AM software: Magics, MeshLab, Rhino, Mimics, Simplant, 3-matic, and Velocity 2.
AM data processing: contour generation, adaptive slicing, toolpath creation, and build-time estimation.

Modeling of AM process factors: surface roughness (staircase effect), accuracy, build stability, and cost estimation.
Part orientation and support structure generation, model slicing, contour data organization, hatching strategies, and adaptive slicing.

UNIT 3 – Post-Processing and Testing of Printed Parts (8 Hours)

Support material removal and cleaning methods; surface finishing techniques (sanding, vapor smoothing, acetone treatment, polishing).
Accuracy and aesthetic improvements; heat treatment and aging; welding and bonding of AM parts.
Defects in AM products: types, causes, and remedies.
Quality inspection and mechanical testing—dimensional accuracy, tolerance evaluation, and strength testing.

Course Outcomes (COs)

After successful completion of this course, students will be able to:

CO1: Explain the principles of pre-processing and slicing techniques in additive manufacturing.
CO2: Operate and analyze the performance of various 3D printing processes (FDM, SLA, DLP, SLS).
CO3: Evaluate post-processing methods and apply inspection techniques for quality assurance.
CO4: Select appropriate materials, process parameters, and software tools for specific AM applications.

Suggested Laboratory Experiments

1. Model slicing and G-code generation using AM software.
2. Fabrication of test samples using FDM, SLA, and DLP printers.
3. Study of process parameter influence (temperature, infill, speed) on part quality.
4. Surface finishing and post-processing of printed components.
5. Infill density vs. strength analysis through mechanical testing.
6. Dimensional accuracy and tolerance measurement using metrology tools.
7. Fabrication and evaluation of a functional product using FDM/SLA/SLS.
8. Documentation and technical reporting from initial sketch to CAD model and printed part.

Laboratory Outcomes:

- Demonstrate ability to prepare and print 3D models using different AM systems.
- Evaluate the effect of process parameters on part quality.
- Perform post-processing and inspection of printed parts.
- Develop end-to-end documentation for a complete 3D printed prototype.

Textbooks

1. Gibson, I., Rosen, D.W., and Stucker, B., Additive Manufacturing Technologies, Springer, 2021.
2. Chua, C.K., Leong, K.F., and Lim, C.S., Rapid Prototyping: Principles and Applications, World Scientific, 2020.

Reference Books

1. Liou, F.W., Rapid Prototyping and Engineering Applications, CRC Press, 2011.
2. Kamrani, A.K., Rapid Prototyping: Theory and Practice, Springer, 2006.
3. Chua, C.K. and Leong, K.F., 3D Printing and Additive Manufacturing: Principles and Applications, 4th Ed., World Scientific, 2014.
4. Gebhardt, A., Rapid Prototyping, Hanser Publishers, 2003.
5. Raja, V., and Fernandes, K., Reverse Engineering: An Industrial Perspective, Springer, 2008.
6. Toyserkani, E., Khajepour, A., and Corbin, S.F., Laser Cladding, CRC Press, 2004.

Coursera/NPTEL Mapping

1	Rapid Prototyping Using 3D Printing Specialization	https://www.coursera.org/specializations/rapid-prototyping-using-3d-printing
2	Additive Manufacturing	https://www.coursera.org/programs/leadership-zextz/learn/additive-manufacturing-3d-printing
3	Rapid Prototyping and Tooling Specialization	https://www.coursera.org/specializations/rapid-prototyping-and-tooling
4	Advances in Additive Manufacturing of Materials: Current status and emerging opportunities	https://nptel.ac.in/courses/113108632

Course Name: Material, Processing & Application of 3D Printing

Course Code: MINOR601M

Credits: 4 (L4-T0-P0)

Course Objectives

- To study the range and characteristics of materials used in additive manufacturing (AM).
- To understand the relationship between material, processing parameters, and resulting part properties.
- To analyze the structure-property correlations and mechanical behavior of AM products.
- To explore advanced and sustainable applications of AM materials across different industries.

Detailed Syllabus

UNIT 1 – Materials for Additive Manufacturing (8 Hours)

Classification of materials for AM: polymers, metals, ceramics, and composites.
Forms of AM materials: powders, filaments, resins, and pellets.
Material properties – particle morphology, flowability, and thermal characteristics.
Material selection criteria for AM applications.
Multifunctional and graded materials in AM – concept, manufacturing strategies, and benefits.
Overview of emerging materials: graphene, smart materials, bioinks, and nanocomposites.

UNIT 2 – Material Processing in Additive Manufacturing (8 Hours)

Overview of key processing techniques: extrusion-based, photopolymerization, powder bed fusion, binder jetting, and directed energy deposition.
Material-process interaction: solidification rate, melt pool dynamics, and thermal history.
Formation of non-equilibrium microstructures and their influence on mechanical properties.
Structure–property relationship and control of porosity, grain size, and anisotropy.
Processing challenges with advanced alloys, ceramics, and composites.

UNIT 3 – Structure and Properties of AM Components (8 Hours)

Microstructural formation and evolution in AM parts.
Common defects in AM: porosity, delamination, cracking, and residual stresses.
Mechanical behavior: tensile, fatigue, and hardness characteristics.
Effect of processing parameters on density, strength, and surface finish.
Characterization techniques: optical microscopy, SEM, XRD, and micro-CT scanning.
Correlation between process, structure, and mechanical performance.

UNIT 4 – Functional and Industrial Applications (8 Hours)

Industrial Applications:
Aerospace, automotive, tooling, and consumer products – case studies of material utilization.
Functional gradient materials for lightweight and high-performance applications.

Biomedical Applications: 3D printing in medicine: customized implants, prosthetics, surgical tools, and anatomical models.
Biocompatibility and material selection for implants.
Emerging materials: bioinks, hydrogels, biodegradable polymers, and smart biomaterials.
Recent trends in bioprinting and regulatory aspects for medical devices.

Creative and Design Fields**:** Applications in architecture, jewellery, art, and product design.

UNIT 5 – Sustainability and Environmental Impact in AM (4 Hours)

Sustainability principles in additive manufacturing.
Material recycling and reuse: powders, filaments, and resins.
Energy efficiency in AM processes and comparative analysis with traditional manufacturing.
Life Cycle Assessment (LCA) of AM products.
Environmental and economic implications of sustainable AM practices.
Future trends: green materials and closed-loop AM systems.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Identify various classes, forms, and characteristics of materials used in AM processes.
CO2: Explain process–structure–property relationships for different AM materials.
CO3: Evaluate the microstructural, mechanical, and thermal behavior of AM components.
CO4: Apply material knowledge to design sustainable, high-performance AM applications in industrial and biomedical sectors.

Textbooks

1. Bandyopadhyay, A. and Bose, S., Additive Manufacturing, CRC Press, 2019.
2. Gibson, I., Rosen, D.W., and Stucker, B., Additive Manufacturing Technologies, Springer, 2021.

Reference Books

1. Gebhardt, A., Understanding Additive Manufacturing, Hanser, 2021.
2. Liou, F.W., Rapid Prototyping and Engineering Applications, CRC Press, 2011.
3. Sequeira, Y.R.D.G., Design for Additive Manufacturing: A Guide to Design for 3D Printing, CRC Press, 2021.
4. Mohamed, T.S.S.S., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, 2017.
5. Snyder, R.L., Materials Selection for 3D Printing in Medicine, Elsevier, 2020.
6. Chawla, S., Biomaterials in Medicine: Advances in Biomaterials and Tissue Engineering, Wiley, 2020.
7. Gibson, J.L., Additive Manufacturing: Materials, Processes, Quantifications, and Applications, Springer, 2018.
8. Raj, B.P.B., FDA Regulatory Approval of 3D Printed Medical Devices, CRC Press, 2019.
9. Rybicki, F.J., and Grant, G.T., 3D Printing in Medicine: A Practical Guide for Medical Professionals, Springer, 2017.

Coursera/NPTEL Mapping

1	3D Printing Applications	https://www.coursera.org/learn/3d-printing-applications?specialization=3d-printing-additive-manufacturing
2	Essentials of Additive Manufacturing	https://www.coursera.org/learn/essentials-of-additive-manufacturing
3	3D Printing Capstone	https://www.coursera.org/programs/iem-uem-program-2024-2dvv9/learn/3d-printing-capstone?specialization=3d-printing-additive-manufacturing

4	Navigating the Latest Trends in Additive Manufacturing Landscape	https://onlinecourses.nptel.ac.in/noc25_me94/preview

Course name: 3D Metal Printing

Course Code: MINOR701M

Credits: 3 (L3-T0-P0)

Course Objectives

- To understand the principles, evolution, and classifications of metal additive manufacturing (AM) processes.
- To study powder characteristics, process parameters, and their effect on build quality.
- To learn post-processing and defect control methods in metal AM.
- To apply design and topology optimization for functional and lightweight metal components.

Detailed Syllabus

UNIT 1 – Fundamentals of Metal Additive Manufacturing (9 Hours)

Overview of metal AM technologies; comparison with conventional manufacturing.
Classification of processes – Powder Bed Fusion (SLM, DMLS, EBM), Directed Energy Deposition (LENS, WAAM), Binder Jetting, Cold Spray, and Hybrid Processes.
Process stages, thermal management, and machine setup.
Case studies on LENS, EBM, and WAAM process workflows.
Integration of reverse engineering with metal AM for repair and remanufacturing.

UNIT 2 – Powder Characteristics and Handling (7 Hours)

Powder production methods: gas atomization, water atomization, mechanical alloying.
Powder properties: morphology, particle size distribution, density, flowability, and contamination control.
Powder reuse and degradation behavior.
Health, safety, and environmental aspects of powder handling.
Testing and characterization of metal powders (Hall flow test, particle analysis, SEM).

UNIT 3 – Process Parameters and Quality Control (7 Hours)

Influence of key parameters: laser/electron beam power, scan speed, layer thickness, hatch spacing, and build orientation.
Melt pool formation, solidification rate, and porosity mechanisms.
Process monitoring techniques: melt pool sensors, thermal imaging, and in-situ feedback.
Process modeling and simulation for quality improvement.
Correlation of process parameters with density, surface finish, and mechanical properties.

UNIT 4 – Post-Processing and Inspection (7 Hours)

Post-processing techniques: heat treatment, hot isostatic pressing (HIP), machining, and surface finishing.
Residual stress relief and microstructure homogenization.
Characterization methods: SEM, XRD, micro-CT scanning, and metallographic analysis.
Defect control: porosity, lack of fusion, microcracks.
Non-destructive testing (NDT) methods: ultrasonic, radiography, and computed tomography.

UNIT 5 – Design Optimization and Industrial Applications (6 Hours)

Design for Metal AM: overhangs, support structures, and build orientation.
Topology and lattice optimization for lightweight structures.
Applications in aerospace, automotive, biomedical, and tooling sectors.
Case studies of functional metal AM components and sustainability considerations.
Standards and certifications in metal AM (ASTM, ISO).

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain and compare various metal additive manufacturing processes and their operating principles.
CO2: Analyze powder characteristics and their impact on process stability and product quality.
CO3: Evaluate process parameters, post-processing techniques, and defect control methods for metal AM.
CO4: Apply design optimization and topology principles to develop lightweight, high-performance metal AM components.

Textbooks

1. Herzog, D., Additive Manufacturing of Metals, Springer, 2020.
2. Gibson, I., Rosen, D.W., and Stucker, B., Additive Manufacturing Technologies, Springer, 2021.

Reference Books

1. Mahamood, R.M., Laser Metal Deposition Process of Metals and Alloys, Springer, 2018.
2. Yap, C.Y., Metal Additive Manufacturing: Fundamentals, CRC Press, 2021.
3. Dutta, B. and Froes, F.H., Additive Manufacturing of Metals: Principles and Applications, Elsevier, 2017.
4. Zhang, Y.M. and Vilaro, T., Metal Additive Manufacturing: Materials, Design, Technologies, and Applications, CRC Press, 2020.
5. DebRoy, T. and Zhang, W., Metal Additive Manufacturing: Materials, Design, Technologies, and Applications, CRC Press, 2021.
6. Shahin, G. and Dickens, P., Metal Additive Manufacturing: Materials, Processes, and Mechanisms, CRC Press, 2022.
7. Khorram, A., Additive Manufacturing of Metallic Materials, Elsevier, 2023.

Coursera/NPTEL mapping:

1	Introduction to 3D Printing with Metals	https://www.coursera.org/learn/introduction-to-3d-printing-with-metals
2	Selective Laser Sintering and Metal Laser Powder Bed Fusion	https://www.coursera.org/learn/selective-laser-sintering-and-metal-laser-powder-bed-fusion
3	3D Printing Technology Deep Dive and Use Cases	https://www.coursera.org/learn/3d-printing-technology-deep-dive-and-use-cases
4	Metal Additive Manufacturing	https://onlinecourses.nptel.ac.in/noc22_me130/preview

Course Name: MINOR801M

Course Code: 3D Printing Project

Credits: 3(L0-T0-P6)

Course Objectives

- To integrate theoretical and practical knowledge gained from previous additive manufacturing (AM) courses into a comprehensive design–fabrication project.
- To enable students to apply suitable design, material, and process selection for a functional 3D printed product.
- To develop skills in testing, validation, and evaluation of mechanical and dimensional accuracy of printed components.
- To cultivate teamwork, project management, and presentation skills through hands-on AM projects.
- To guide students in preparing professional technical documentation and cost–benefit analyses of developed products.

Detailed Syllabus

Project Work Structure

Students shall undertake a **team-based or individual project** involving the complete product development cycle using additive manufacturing technologies.

Stages of the Project:

1. **Problem Identification and Conceptualization**
    - Selection of real-world design/manufacturing problems or innovative ideas.
    - Literature review and benchmarking of existing solutions.
2. **Design and Modeling**
    - Concept sketching and 3D CAD modeling (solid/surface modeling).
    - Design for Additive Manufacturing (DfAM) principles: topology optimization, lattice structures, and part consolidation.
3. **Material and Process Selection**
    - Selection of suitable AM materials (polymers/metals/composites) based on functional requirements.
    - Identification of appropriate AM process (FDM, SLA, SLM, DED, etc.) and parameters.
4. **Fabrication and Post-Processing**

    - 3D printing of designed component using suitable machine.
    - Post-processing operations such as support removal, surface finishing, and heat treatment (if applicable).
5. **Testing and Validation**
    - Dimensional inspection, surface roughness, mechanical strength, and functionality evaluation.
    - Comparison between designed and fabricated models.
    - Cost and time analysis for production feasibility.
6. **Documentation and Presentation**
    - Preparation of a comprehensive project report including objectives, methodology, results, and conclusions.
    - Preparation of poster/presentation for project defense and evaluation.

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Apply principles of additive manufacturing in developing a functional prototype or product.
CO2: Design, model, and fabricate components using appropriate AM processes and materials.
CO3: Perform testing, analyze data, and validate mechanical, dimensional, and functional aspects of printed parts.
CO4: Prepare technical documentation, evaluate cost-effectiveness, and effectively communicate project outcomes.