

**ADDITIVE MANUFACTURING**  
**B.E, VIII Semester, Mechanical Engineering**  
**[As per Choice Based Credit System (CBCS) scheme]**

Course Code	17ME82	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03

**Credits – 04**

**Course Objectives:**

1. Understand the additive manufacturing process, polymerization and powder metallurgy process
2. Understand characterisation techniques in additive manufacturing.
3. Acquire knowledge on CNC and Automation.

**Module - 1**

**Introduction to Additive Manufacturing:** Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, **AM process chain:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing.

**Classification of AM processes:** Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system.

**Post processing of AM parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

**Guidelines for process selection:** Introduction, selection methods for a part, challenges of selection

**AM Applications:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries.

**Module - 2**

**System Drives and devices:** Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features

**Actuators:** Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, and Triacs. Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

**Module - 3**

**POLYMERS & POWDER METALLURGY**

**Basic Concepts:** Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] **Polymer Processing:** Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques

**General Concepts:** Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM

**Powder Production Techniques:** Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes.

**Characterization Techniques:** Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization

**Microstructure Control in Powder:** Importance of Microstructure Study, Microstructures of Powder by Different techniques.



**Powder Shaping:** Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting.  
**Sintering:** Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components  
**Application of Powder Metallurgy:** Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc.

#### Module - 4

#### NANO MATERIALS & CHARACTERIZATION TECHNIQUES:

**Introduction:** Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology  
**Nano-materials Synthesis and Processing:** Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC).

**Optical Microscopy** - principles, Imaging Modes, Applications, Limitations.

**Scanning Electron Microscopy (SEM)** - principles, Imaging Modes, Applications, Limitations. **Transmission Electron Microscopy (TEM)** - principles, Imaging Modes, Applications, Limitations. **X-Ray Diffraction (XRD)** - principles, Imaging Modes, Applications, Limitations. **Scanning Probe Microscopy (SPM)** - principles, Imaging Modes, Applications, Limitations. **Atomic Force Microscopy (AFM)** - basic principles, instrumentation, operational modes, Applications, Limitations. **Electron Probe Micro Analyzer (EPMA)** - Introduction, Sample preparation, Working procedure, Applications, Limitations.

#### Module - 5

#### MANUFACTURING CONTROL AND AUTOMATION

**CNC technology - An overview:** Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC **Part programming:** CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming Computer aided part programming (APT)

**Introduction:** Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity

**Control Technologies in Automation:** Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components.

#### Course outcomes:


1. Understand the different process of Additive Manufacturing. using Polymer, Powder and Nano materials manufacturing.
2. Analyse the different characterization techniques.
3. Describe the various NC, CNC machine programing and Automation techniques.

#### TEXT BOOKS:

1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.
2. G Odian Principles of Polymerization, Wiley Interscience John Wiley and Sons, 4th edition, 2005
3. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
4. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.
6. Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

**REFERENCE BOOKS:**

1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000
2. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

  
**H.O.D.**

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