

B. E. MECHANICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII Professional Elective 3			
ADDITIVE MANUFACTURING			
Course Code	18ME741	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing. To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing. To get exposed to process selection, software issues and post processing. 			
Module-1			
Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereolithography or 3dprinting, rapid prototyping, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology. Development of Additive Manufacturing Technology: Introduction, computers, computer-aided design technology, other associated technologies, the use of layers, classification of AM processes, metal systems, hybrid systems, milestones in AM development. Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another, metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.			
Module-2			
Photo polymerization processes: Stereolithography (SL), Materials, SL resin curing process, Micro-stereolithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes. Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes. Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.			
Module-3			
Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems, process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks. Direct Write Technologies: Background, ink-based DW, laser transfer, DW thermal spray, DW beam deposition, DW liquid-phase direct deposition.			
Module-4			

Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.

Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.

Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Module-5

The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions.

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, defense, automobile, Bio-medical and general engineering industries.

Direct digital manufacturing: Align Technology, siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.

Course Outcomes: At the end of the course the student will be able to:

- CO1: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- CO2: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- CO3: Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
- CO4: Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
- CO6: Understand characterization techniques in additive manufacturing.
- CO7: Understand the latest trends and business opportunities in additive manufacturing.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing	I. Gibson I D. W. Rosen I B. Stucker	Springer New York Heidelberg Dordrecht, London	ISBN: 978-1-4419-1119-3 e-ISBN: 978-1-4419-1120-9 DOI 10.1007/978-1-4419-1120-9
Reference Books				
1	"Rapid Prototyping: Principles & Applications	Chua Chee Kai, Leong Kah Fai	World Scientific	2003
2	Rapid Prototyping: Theory & Practice	Ali K. Kamrani,	Springer	2006

		EmandAbouel Nasr,		
3	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling”	D.T. Pham, S.S. Dimov	Springer	2001
4	Rapid Prototyping: Principles and Applications in Manufacturing	RafiqNooran	John Wiley & Sons	2006
5	Additive Manufacturing Technology	Hari Prasad, A.V.Suresh	Cengage	2019
6	Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing	Andreas Gebhardt	Hanser Publishers	2011