BMEE408E	Additive Manufacturing	L	T	P	C
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Pre-requisite	**BMEE306L , BMEE306P**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the knowledge on additive manufacturing fundamentals and various 3D printing technologies.
2. To familiarize the concept of preprocessing and post processing methods for the additive manufacturing.
3. To explore the various 3D printing tools for components.

Course Outcome

At the end of the course, the student will be able to

1. Demonstrate the concepts, capabilities and limitations of additive technologies.
2. Develop 3D components using various software and 3D printing tools.
3. Construct customized extrusion-based 3D printers for specific choice of applications.
4. Explore the capabilities and design freedom provided by 3D printing technologies.
5. Recognize the post processing concept for additive Manufacturing.

Module:1	**Introduction to Additive Manufacturing**	**6 hours**

Additive Manufacturing Terminologies – Concepts of Layer Manufacturing – Additive Manufacturing Vs Subtractive Manufacturing – Custom, Batch and Mass Production Scenarios – Role of AM in Product Development – Applications of AM in Automotive, Aerospace and Bio-medical.

Module:2	**Planning for Additive Manufacturing**	**6 hours**

3D Model Data Creation, Concept of Reverse Engineering, Data collection, Modeling for printing – File Formats: STL, OBJ, AMF, 3MF, CLI – STL file Errors, Correction and Printability Analysis – Optimization of Part Orientation and Support Structure Generation - Types of Supports – Slicing Parameters – Tool Path Generation.

Module:3	**Additive Manufacturing Technologies**	**6 hours**

Extrusion Based Technologies – FDM, Stereolithography and other Photo polymerization based Technologies – SLA & DLP, Laser Sintering – SLS & DMLS, Laser and Electron Beam Powder Bed Fusion Technologies – SLM&EBM, Wire and Powder based Direct Energy Deposition Technologies – Material Jetting – Binder Jetting – Hybrid AM Processes.

Module:4	**Post-Processing for Additive Manufacturing**	**6 hours**

Support Structure Removal – Surface Texture Improvement – Surface Treatments – Polymer & Metal ,Heat Treatment – HIP & Residual Stress Relieving, UV Curing – Cleaning & de-powdering – Machining – Surface Coating & Infiltration.

Module:5	**Design for Additive Manufacturing**	**6 hours**

General Guidelines – Exploring Unique Capabilities and Design Freedom – Complex Geometries – Customized Geometries – Part Consolidation – Tooling Design – Design Guidelines for Printing Polymer parts, Metal parts, Ceramic and Sand mould – Functionality based DFAM – Case Studies.

Module:6	**AM Simulation and Characterization Techniques**	**7 hours**

Traditional analysis – Microstructural Analysis – Parameter Optimization – Failure Detection – Wetting Behaviour – Balling Effect – Stress Analysis – Melt Pool Life – Heat transfer phenomena – Defects analysis.

Module:7	**Materials for AM**	**6 hours**

Selection of candidate materials for Additive Manufacturing, Nature of Polymers for AM environment , Am thermoplastics and thermosetting polymers, Types of Polymerizations at 3D printing environment, Properties of Polymers based on FDM, SLA/DLP, and SLS, Degradation of Polymers after printing, Metal and Ceramic Powders for AM, Composites, Functionally Graded Materials (FGM's) for 3D printing.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Books		
1.	Andreas Gebhardt, Jan-Steffen Hötter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, 2016, Hanser Publishers, Munich.	
2.	Olaf Diegel, Axel Nordin, Damien Motte, A Practical Guide to Design for Additive Manufacturing, 2020, Springer Nature Singapore Pte Ltd.	
3.	C P Paul , A N Jinoop, Additive Manufacturing – Pricniples, technologies and Applications, 2021, Mc Graw Hill Publication.	
Reference Books		
1.	Ben Redwood, Filemon Schöffer, Brian Garret, The 3D Printing Handbook, 2017, 3D Hubs.	
2.	Srivatsan, T. S., Sudarshan, T. S, Additive manufacturing: innovations, advances, and applications, 2016, CRC Press.	
Mode of Evaluation: CAT, Assignment, Quiz, FAT, Lab		
Indicative Experiments		
1	3D CAD model creation by Reverse Engineering.	
2	Printing and dimensional evaluation of simple part with one material / one colour – FDM.	
3	Printing and dimensional evaluation of simple part with two material / two colour – FDM.	
4	Printing and dimensional evaluation of simple part by SLS.	
5	Printing and evaluation of simple part by SLA/DLP.	
6	Evaluation of print orientation (x, y, z) effects on ASTM standard Tensile Test specimen using FDM	
7	Evaluation of print orientation (x, y, z) effects on ASTM standard Tensile Test specimen using SLS	
8	Evaluation of print orientation (x, y, z) effects on ASTM standard Tensile Test specimen using SLA	
9	Comparing the surface quality of the parts printed at different print orientation using FDM.	
10	Finding optimum depth to diameter ratio to print holes using FDM.	
11	Finding optimum width to length ratio to print square beams using FDM.	
12	Demo on SLM.	
	Total Laboratory Hours	**30 hours**
Text Book		
1.	Lab Manual prepared by course faculty members	
Mode of assessment: Continuous assessment, FAT, Oral examination and others		
Recommended by Board of Studies	09-03-2022	
Approved by Academic Council	No. 65	Date 17-03-2022