ADDITIVE MANUFACTURING TECHNOLOGY (ME711PE)

I. COURSE PURPOSE:

This course bridges gap between idea and production. Rapid prototyping is a group of methods used to rapidly manufacture a scale model of a physical part or assembly using three-dimensional computer aided design (CAD), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) data. Construction of the part or assembly is usually done using 3D printing technology. Rapid prototyping techniques are often referred to solid free; computer automated manufacturing, form fabrication. This course covers the knowledge of rapid prototyping systems.

II. PREREQUISITE(S):

Manufacturing process, Engineering Materials

III. COURSE OBJECTIVES:

S.No	Course Objectives
1	To Understand the Rapid Prototype process.
2	Identify the application for rapid prototyping.
3	To Understand the Application for Liquid based rapid prototyping systems
4	To Understand the Application for powder based rapid prototyping systems
5	To Understand the Rapid Prototyping Data Formats

IV. COURSE OUTCOMES:

S.No	Course Outcomes(CO)	Bloom's Taxonomy Level
At the end of the course, students should be able to:		
CO1	Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.	L1, L2, L3
CO2	Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.	L1, L2, L3
CO3	Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.	L1, L2, L3
CO4	Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.	L1, L2, L3
CO5	Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.	L1, L2, L3

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes(PO)	Level	Proficiency assessed by

PO1	Engineering Knowledge: Capability to apply knowledge of Mathematics, Science Engineering in the field of Mechanical Engineering	3	Seminar
PO2	Problem Analysis: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of Mathematics, Science and Engineering.	3	Seminar
PO3	Design/ Development of solution: Competence to design a system, component or process to meet societal needs within realistic	1	Projects
PO4	Conduct Investigation of complex problems: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Projects
PO5	Modern Tool usage: An ability to formulate solve complex engineering problems using modern engineering and information technology tools.	N	Projects
PO6	The Engineer society: To utilize the engineering practices, techniques, skills to meet needs of health, safety legal, cultural and societal issues.	N	--
PO7	Environment and Sustainability: To understand the impact of engineering solution in the societal context and demonstrate the knowledge for sustainable development.	N	--
PO8	Ethics: An understanding and implementation of professional and Ethical responsibilities.	N	--
PO9	Individual Team work: To function as an effective individual and as a member or leader in multi-disciplinary environment and adopt in diverse	N	--
PO10	Communication: An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.	N	--
PO11	Project Management and Finance: An ability to provide leadership in managing complex engineering project at multi-disciplinary environment and to become a professional engineer.	N	--
PO12	Life-Long learning: Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	1	Projects

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Outcomes(PO)		Level	Proficiency assessed by
PSO1	Professional Skills: To produce engineering professional capable of synthesizing and analyzing mechanical system including allied engineering streams.	3	Lectures, Seminars

PSO2	Design/ Analysis: An ability to adapt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Projects
PSO3	Successful Career and Entrepreneurship: To build the nation by imparting technological inputs and managerial skills to become Technocrats.	2	Guest Lectures

VII. JNTUH SYLLABUS

UNIT - I

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages, and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

UNIT - II

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based RapidPrototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT - III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT - IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT - V

RP Applications : Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

TEXT BOOKS:

Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications

Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer

REFERENCE BOOKS:

Terry Wohlers, Wholers Report 2000, Wohlers Associates

Rapid Prototyping and Manufacturing /PaulF.Jacobs/ASME

LESSON PLAN- COURSE SCHEDULE (WEEK-WISE):

1	**1**	Introduction: Rapid prototyping fundamentals	Introduction, Definition Types of prototype	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?usp=sharing	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8HGPZKS6bh?usp=sharing		L2-Understand	Board and PPT	OR/Taha/PHI
2		Historical development	Introduction First Phase Second Phase Third phas	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?usp=sharing	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8HGPZKS6bh?usp=sharing		L2-Understand	Board and PPT	OR/Taha/PHI
3		Fundamentals of Rapid Prototyping	CAD CAM STL file format Slice	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?us	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8		L2-Understand	Board and PPT	OR/Taha/PHI

				p=sharing	HGPZKS6bh?usp=sharing				
4									
5		Advantages and Limitations of Rapid Prototyping	Introduction Applications Direct benefits Benefits to the Tooling and Manufacturing Engineer Benefits to marketing	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?usp=sharing	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8HGPZKS6bh?usp=sharing		L2-Understand	Board and PPT	OR/Taha/PHI
6		Classification of RP process	Introduction Liquid bases Powdered base Solid based	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?usp=sharing	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8HGPZKS6bh?usp=sharing		L2-Understand	Board and PPT	OR/Taha/PHI
7		Commonly used Terms	RP RPTM Direct CAD Manufacturing, Desktop Manufacturing and Instant Manufacturing	https://drive.google.com/drive/folders/1OwSghrIk7Zb63G4PrblfjjmFjnB8jf1N?usp=sharing	https://drive.google.com/drive/folders/15-x7JT0r3td7wEYVZ4Xi6i8HGPZKS6bh?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
8		**Student PPT**							
9	**2**	Stereolithography Apparatus (SLA)	Introduction, Application Overview	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

10		Models and specifications	Introduction Products Models and specifications SLA 250/30A SLA 250/50 SLA-250/50 HR SLA 3500	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
11		SLA working principles	Introduction Process Resin Laser Part manger module Slice module	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
12		**Student PPT**							
13		Photopolymers, Photo polymerization	Introduction Electron-beam (EB) SLA Photo polymerization PMMM	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
14		Layering technology	Introduction laser and laser scanning Applications Advantages and Disadvantages	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
15		Solid ground curing	Introduction Theory Models and	https://drive.google.com/dri	https://drive.google.com/drive/f		L1 & L2 Underst	Board and PPT	OR/Taha/PHI

		(SGC)	specifications Process	ve/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	olders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		and		
		Student PPT							
16		**Student PPT**							
17		Solid-based Rapid Prototyping Systems:	Laminated Object Manufacturing (LOM) Models and specifications Process working principle Applications, Advantages and Disadvantages	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L3 apply	Board and PPT	OR/Taha/PHI
18		Fused	Models and	https://d	https://driv		L1 &	Board	OR/T
19		Fused Deposition Modeling (FDM) case studies	Introduction Examples Case Studie	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharing		L3 apply	Board and PPT	OR/Taha/PHI
20		**Student PPT**							
21		FDM for Production Tooling	Introduction Applications Concepts	https://drive.google.com/drive/folders/1e8WU-u_XPEFfbqbuV-OXF7Kq	https://drive.google.com/drive/folders/16x4z7peKI336QZWK1igRADNlJ59JymjJ?usp=sharin		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

				EV_t_2sI?usp=sharing	g				
22		Powder Based Rapid Prototyping Systems	Introduction Applications Models Advantages and Disadvantages	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L3 & L4 Apply and Analyze	Board and PPT	OR/Taha/PHI
23		Selective laser sintering (SLS)	Introduction Models and specifications, Process Working Principle	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L3 & L4 Apply and Analyze	Board and PPT	OR/Taha/PHI
24	**3**	**Student PPT**							
25		SLS Applications	Advantages Disadvantages Case studies.	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
26		Three	Introduction	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://driv		L1, L2,	Board	OR/T
		Deposition Modeling (FDM)	specifications Process working	rive.google.com/drive/folders/1e8W	e.google.com/drive/folders/16x4z7peKI3		L2 Understand	and PPT	aha/PHI

			principle Applications, Advantages and Disadvantages	U-u_XPEFfbqbuV-OXF7KqEV_t_2sI?usp=sharing	36QZWK1igRADNlJ59JymjJ?usp=sharing				
27		(3DP) Applications	Advantages Disadvantages Case studies	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L1, L2, L3 and L4	Board and PPT	OR/Taha/PHI
28		**Student PPT**							
29		Rapid Tooling	Introduction Rapid Tooling (RT	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
30		Rapid Tooling	Conventional Tooling Vs RT Need for RT Rapid Tooling Classification	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
31		Indirect Rapid Tooling Methods	Introduction Theory Classification	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI

32		**Student PPT**							
33		Investment Casting	Introduction Applications Case studies Freeze Cast Process (FCP)	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
34		Direct Rapid Tooling	Introduction Applications Case studies Direct AIM, LOM Tool	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
35		DTM Rapid Tool Process	Introduction Applications Overview Tool Process Tooling methods	https://drive.google.com/drive/folders/1IYtuNJHSlVsFKltGVTfk78YNzCa5cOkM?usp=sharing	https://drive.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L3 & L4 Apply and Analyze	Board and PPT	OR/Taha/PHI
		dimensional Printing (3DP)	Models and specifications, Process Working Principle		e.google.com/drive/folders/1RYSW36YK47SRD4rxSPR-gq3Oh-8eDOmd?usp=sharing		L3 and L4	and PPT	aha/PHI
36		**Student PPT**							
37	**4**	Rapid Prototyping Data Formats	Introduction Format types Other Translators RP	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCpp		L3 & L4 Apply and Analyze	Board and PPT	OR/Taha/PHI

			Software's	mQY5RDw1IOFGUXdL?usp=sharing	FQEUvZw?usp=sharing				
38		STL Format	Introduction Definition STL File Problems Consequence of Building Valid and Invalid Tessellated Models	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L3 & L4 Apply and Analyze	Board and PPT	OR/Taha/PHI
39		STL file Repairs:	Introduction Generic Solution Other Translators Newly Proposed Formats	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
40		**Student PPT**							
41		Rapid Prototyping Software's	Features of various RP software's Magics, Mimics Solid	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
42		STL View	Introduction View Expert 3 D View Velocity 2	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI

				usp=sharing					
43		**Student PPT**							
44		Special algorithms	Introduction Two or more gaps formed from a coincidental vertex. Degenerate facets. Overlapping facet	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
45		OTHER	Introduction	https://d	https://driv		L2	Board	OR/T
46		Newly	Introduction	https://dr	https://driv		L2	Board	OR/T
47		RP Applications	Introduction Classifications Applications Materials Design Engineering Analysis and planning	https://drive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	https://drive.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		L2 Understand	Board and PPT	OR/Taha/PHI
48	**5**	Material Relationship	Introduction Finishing Process Machining: milling Lathe boring, grinding, etc.	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
49		APPLICATIONS IN DESIGN	CAD Model Verification Visualizing Objects Proof of Concept Commercial Applications	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

				W?usp=sharing					
50		APPLICATIONS IN ENGINEERING, ANALYSIS AND PLANNING	Introduction Scaling Form and Fit Flow Analysis Stress Analysis Mock-Up Parts	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
51		APPLICATIONS IN MANUFACTURING AND TOOLING	Introduction Tooling classification Soft Tooling Hard Tooling Direct and Indirect	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
52		Indirect Soft Tooling	Introduction Arc Spray Metal Tooling Silicon Rubber Molds Spin Casting with Vulcanized Rubber Mold Castable Resin Mold Castable Ceramic Molds Plaster Molds	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
53		Direct Hard Tooling	Introduction RapidTool Laminated Metal Tooling	https://drive.google.com/drive/folders/1WXL	https://drive.google.com/drive/folders/13zabogvuseq		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

			Direct Metal Laser Sintering (DMLS) Tooling ProMetalTM Rapid Toolin	TBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	NpsWhcwGdg3i-dru88EwB?usp=sharing				
		TRANSLATORS	IGS file HP/GL File CT Data	rive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	e.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		Understand	and PPT	aha/PHI
54		Indirect Hard Tooling	3D Keltool EDM Electrodes Ecotool Copy Milling	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
55		Applications in Aerospace Industry	Introduction Application areas Gas turbine engine Fanjet Engine Production castings	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
56		Applications in automotive industry	Introduction Application areas Gear Box Driver control systems Engine block	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2B	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=shari		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

			Structure	q3V-W?usp=sharing	ng				
		proposed formats	SLC File Definitions and terms SLC File Specifications Data formats	ive.google.com/drive/folders/1h_EPMPH4bq1TjHk6mQY5RDw1IOFGUXdL?usp=sharing	e.google.com/drive/folders/1D0HJbZwUSjzed7rIB4qLItCppFQEUvZw?usp=sharing		Understand	and PPT	aha/PHI
57		Other Industries	Biomedical Brain tumor surgey Needle design Knee implants Tissue engineering \ Inter-Vertebral Spacers	https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI
58		Revison		https://drive.google.com/drive/folders/1WXLTBbW130CuhCwxZMa635Q0O2Bq3V-W?usp=sharing	https://drive.google.com/drive/folders/13zabogvuseqNpsWhcwGdg3i-dru88EwB?usp=sharing		L1 & L2 Understand	Board and PPT	OR/Taha/PHI

VIII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OFPROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

IX. **QUESTION BANK JNTUH**

Unit I : Short Answer Questions:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	2	2	--	--	--	--	--	--	--	--	--	2	2	2	--
C02	1	2	2	--	--	--	--	--	--	--	--	--	1	2	--
C03	1	2	1	--	--	--	--	--	--	--	--	---	2	--	1
C04	2	1	--	--	--	--	--	--	--	--	--	--	2	1	--
C05	2	1	---	--	--	--	--	--	--	--	--	--	2	1	1

Q.No	Questions	Bloom's Taxonomy Level	Course Outcome
1	Why rapid prototyping is important in industries.	Understand	2
2	How rapid prototyping systems are classified. Give the example for each classification.	Understand	2
3	Explain the key aspects of rapid prototype technologies.	Understand	2
4	What meant by rapid prototype. What are the roles of prototype in development process.	Understand	2
5	Explain in detail the common information work flow indicating the main stage of rapid prototyping system work flow.	Understand	2
6	Describe the steps involved in rapid process chain.	Understand	2
7	Briefly classify the rapid prototyping systems	Understand	2
8	List out the advantages of rapid prototyping process	Understand	2
9	"Establish a statement that rapid prototyping is limited to some application" Justify your statement.	Understand	2
10	Explain the limitations of rapid prototyping.	Understand	2
11	Establish a statement how rapid prototyping is used in automation.	Understand	2
12	Explain rapid prototyping. Classification of rapid prototyping system.	Understand	2
Unit I : Long Answer Questions:			
1	Explain the history of rapid prototyping systems and its fundamental development.	Knowledge	1
2	Explain the need of rapid prototyping	Knowledge	1
3	List out the classification of rapid prototype systems.	Knowledge	1
4	Explain in detail the process chain rapid prototyping.	Knowledge	1

5	Discuss limitations of rapid prototyping explain in detail.	Knowledge	1
6	Write short notes on advantages of rapid prototyping.	Knowledge	1
7	Classify rapid prototyping and give its basic principle.	Knowledge	1
Unit II : Short Answer Questions:			
1	Define the fundamental principle of stereo lithography process.	Understand	2
2	Explain alternating direction implicit method.	Understand	2
3	Define fused deposition modeling.	Knowledge	2
4	Compare solid based rapid prototyping and liquid based rapid prototyping.	Knowledge	2
5	Differentiate between stereo lithography and solid ground curing.	Knowledge	2
6	Define laminated object manufacturing and specification.	Knowledge	2
7	Explain the advantages of liquid based stereo lithography.	Knowledge	2
8	Explain merits of fused deposition modeling.	Knowledge	2
9	List out the application of fused deposition modeling.	Understand	2
10	Explain laminated object manufacturing and its applications.	Understand	2
Unit II : Long Answer Questions:			
1	Compare and contrast the liquid-based stereo lithography systems and the solid ground curing systems. What are the advantages disadvantages for each of the systems.	Understand	2
2	Explain in details the working principle of solid ground curing models with its advantages and disadvantages. Differentiate SLA and SLS in rapid prototyping	Understand	2
3	Explain merits and demerits of Laminated Object Manufacturing. Describe the principle of FDM with its advantages, disadvantages and applications	Understand	2
4	Explain with the help of simple line diagram explain the construction details of extrusion head in FDM process.	Understand	2
5	Describe Fused deposition modeling process with a neat sketch.	Understand	2
Unit III: Short answer questions:			
1	Explain the selective laser sintering.Process.	Understand	3
2	Explain the three dimensional printing.	Understand	3
3	Discuss the advantages and disadvantages of Selective laser sintering.	Understand	3
4	Write the applications of 3DP.	Understand	3
5	Explain the powder based rapid prototyping.	Knowledge	3
6	What is rapid tool and list out its advantages?	Knowledge	3
7	Differentiate soft tooling and hard tooling.	Understand	3
8	What is investment casting?	Understand	3

9	Explain vaccum casting.	Understand	3
10	What are the applications of FDM models. Give an example.	Knowledge	3
11	What is the need of rapid prototyping while conventional tooling are existing.	Knowledge	3
Unit III: Long answer Questions:			
1	Explain the critical factors that influence the performance and functions of Selective Laser Sintering and 3-Dimentional printing.	Understand	3
2	Discuss the advantages and disadvantages of powder based rapid prototyping system and compare with liquid based and solid based rapid prototyping systems	Understand	3
3	Discuss the merits and demerits of selectivelaser sintering process.	Understand	3
4	Discuss the principle of three dimensional printing process using a case study.	Understand	3
5	Discuss the principle of selective laser sintering process using a case study	Understand	3
6	What is rapid tooling and explain about evaporative pattern casting process	Understand	3
7	Explain about evaporative pattern with a neat sketch.	Knowledge	3
8	What is rapid tooling and explain the application of rapid prototype tool in manufacturing and tooling.	Knowledge	3
9	What is rapid tooling and explain about shell investment casting process with its advantages and disadvantages.	Knowledge	3
Unit IV: Short answer questions			
1	Discuss on STL files and define slicing relevant to CAD.	Knowledge	4
2	Explain the features of various rapid prototyping softwares.	Knowledge	4
3	Explain the consequences of building valid and invalid tessellated models.	Knowledge	4
4	Explain the concept occurring errors in SH files.	Knowledge	4
5	Explain the concept of file exchange errors	Understand	4
6	Explain the data format in rapid prototyping.	Understand	4
7	Explain the softwares in rapid prototyping.	Understand	4
Unit IV: Long answer questions			
1	Explain the STL format. Discuss the Generic and dedicated solution with example.	Apply	4
2	Explain the procedure of modeling, STL file creation and layering steps before printing 3D model in RP machine for the following types of models (i) Economical model. (ii) Precision model	Apply	4
3	Differentiate soft tooling and hard tooling and also Compare direct tooling and indirect tooling.	Apply	4
4	Explain the futures of RP software and summarize about solid view, view expert, 3D view and STL view in detail.	Apply	4
5	Write short on following. (i) Influence of building orientation.	Apply	4

	(ii) File exchange errors. (iii) Errors in STLfiles. (iv) Part building errors.		
6	Explain the procedure of modeling, STL file creation and layering steps before printing 3D model in RP machine for the following types of models (i) Economical model. (ii) Precision Model	Apply	4
7	Differentiate soft tooling and hard tooling and Compare direct tooling and indirect tooling.	Apply	4
8	Explain Arc spray metal tooling with a neat sketch	Apply	4
9	Explain the futures of RP software and summarize about solid view, view expert, 3D view and STL view in detail.	Apply	4
Unit V: Short Answer Questions			
1	Explain with a suitable example the application of rapid prototyping in aerospace industry.	Knowledge	5
2	Which rapid prototyping processes are best suited for production of ceramic part. why.	Knowledge	5
3	How does aerospace technology make use of rapid tooling application.	Knowledge	5
4	Summarize the applications of rapid prototyping in various industries.	Understand	5
5	Summarize the applications of rapid protyping in automotive sector.	Understand	5
6	List out the applications of rapid prototyping in aerospace industry.	Understand	5
7	Generalize the statement “material relationship effects the rapid prototyping”.	Understand	5
8	Explain the application of analysis and planning in rapid prototyping.	Understand	5
9	How the rapid prototyping is useful in the arts and architecture.	Understand	5
10	Write the applications of customized implants and prosthesis.	Understand	5
Unit V: LongAnswer Questions			
1	Explain the applications of rapid prototyping. Summarize the application in coin making, coin industry, GIS application.	Apply	5
2	Categorize the applications of rapid prototyping in the areasof customized implants and prosthesis, visualization of biomolecules.	Apply	5
3	Discuss with a case study in automobile application. Describe how reverse engineering will be applied to rapid prototyping techniques.	Apply	5
4	Categorize how the material relationship will contribute in rapid prototype technique. Specify the applications in aerospace industry.	Apply	5

5	Explain the applications of rapid prototyping. summarize the applications in engineering, analysis, aerospace industry, medical and bioengineering.	Apply	5
6	Categorize the applications of rapid prototyping in the areas of planning and simulation of complex surgery, customized implants, design and production of medical devices.	Apply	5
7	Discuss with a case study in medical application. Describe how reverse engineering will be applied to rapid prototyping techniques.	Apply	5
8	Categorize how the material relationship will contribute in rapid prototype technique specify the applications in forensic science and anthropology	Apply	5
9	Discuss with a cases study how design and production of medical devices are done by the rapid prototyping.	Knowledge	5
10	Explain how forensic science and anthropology uses rapid prototyping technique.	Understand	5

IX. OBJECTIVE QUESTIONS: JNTUH.

UNIT I

1. Additive mfg uses much less material than other subtractive mfg processes.

True False

2. You can send a file through a usb cable, thumb drive, or cloud server to the machine.

True False

3. File type most commonly exported from CAD software?

SLDRT JPG STL X3G

4.Which should be considered when orienting the part on the build plate in the slicing software?

Holes should always be printed horizontally

The footprint of the part should be as small as possible.

You should minimize the number of overhangs.

All of the above

5.Solidworks Design Guidance function produces much more organic and unique geometry than other modelled by the user.

True False

6.Prototype contains three aspects of interests

i)Implementation,ii)_____,iii)_____

7.Four aspects of RP, they are Input,_____,_____,_____ and applications.

8.All RP systems can be easily categorized into i)_____,ii)_____, and_____.

9.Three fundamental fabrications are i)_____,ii)_____ and iii)_____.

10.After 3D geometric modelling, a user can make a part through NC programming or through RP ?

True False

11.STL files are problematic ?

True False

UNIT II

1.Which of the following is typically the most expensive type of 3D printer.

SLA SLM FDM None of the above

2.FDM stands for Fused Deposition Modelling.

True False

3.SLA stands for Stereolighting Amplification.

True False

4.FDM printers can print multiple materials at one time.

True False

5.Which type of printer uses an enclose build area?

SLA SLS MDS FDM

6.New Material in a FDM printer should have material pushed through the nozzle.

True False

7.You can pause a 3d print to check for material.

True False

8.SLA printers automatically heat the resin.

True False

9.FDM material must be oriented, strand loaded, and checked for kinks.

True False

10.FDM build plates are prepared by..

Putting hair spray on it.

Putting a layer of painters tape on it.

Putting a glue stick layer on it.

All the above

UNIT III

1.3D printing technology is expanding and is now able to print metal parts.

True False

2.Which type of 3D printer uses a pool of resin to create the solid part?

FDM SLA SNL none of the above

3.What material is not used in 3D printing?

Nylon ABS PLA PVC

4.All cad software titles can export 3D printable part files.

True False

5.All 3D parts will stick together using superglue to hold them.

True False

6.Scaling a part can help it account for shrinkage and make the correct final dimensions.

True False

7..All cad software titles can export 3D printable part files.

True False

8.All 3D parts will stick together using superglue to hold them.

True False

9..Food items can be printed using a 3D printer

True False

UNIT IV

1.All 3D parts will stick together using superglue to hold them.

True False

2.Scaling a part can help it account for shrinkage and make the correct final dimensions.

True False

3.If a part includes a 1 mm rod feature, it should be slightly undersized to fit inside a 1 mm hole.

True False

4.A printed part should be allowed to cure before testing if it fits.

True False

5.Water soluble material allows you to use alcohol to remove support material.

True False

6.SLA printers use isopropyl alcohol baths to clean parts.

Ture False

7.All support material can be removed by hand.

True False

8.If a part includes a 1 mm rod feature, it should be slightly undersized to fit inside a 1 mm hole.

True False

UNIT V

1.Some 3D printer models have fixtures that mount and hold the build platform.

True False

2.Blue painters tape is the most difficult to remove from printed parts

True False

3.Sharp edges should point away from you when prying parts.

True False

4.Solidworks Design Guidance function produces much more organic and unique geometry than other modelled by the user.

True False

5.Typical applications of RP in industries are_____,_____, Jewellery,_____ and_____

6._____ are necessary for product manufacturing in aerospace, automobile, and biomedical.

7.Classification of rapid tooling are_____, and _____.

8.DLMS stands for _____.

9.Stereolithography is used to produce _____.

10._____ and _____ are some of the components used in biomedical industry.

11.RP systems can be applied to traditional systems like _____ and _____.

12.Some general steps involved in the art to part process are _____,_____, and _____.

13.Automobile industry uses RP techniques to produce some components like _____,_____, and _____.

XI. Web References:

1. http://nptel.ac.in/courses/112107077/38
2. http://web.iitd.ac.in/~pmpandey/MEL120_html/RP_document.pdf

XII. E-Text Book:

1. https://books.google.co.in/books?id=4OYcyiDUpsQC&redir_esc=y
2. http://store.elsevier.com/Direct-Write-Technologies-for-Rapid-Prototyping-Applications/isbn- 9780121742317/

XIII. SUBJECT EXPERTS:

1. N. Sinha Department of Mechanical Engineering IIT Kanpur.
2. Dr.P.Mallesam Department of Mechanical Engineering, MVSR, OU.