TEACHING PLAN: RAPID PROTOTYPING

SCHOOL OF ENGINEERING AND TECHNOLOGY		**ACADEMIC SESSION: 2022-23**		**FOR STUDENTS' BATCH: 2019-2023**	
1	**Course code**	**PCC-ME 405**			
2	**Course Title**	**RAPID PROTOTYPING**			
3	**Credits**	**3**			
4	**Learning Hours**	**Contact Hours: 3** **Practical Teaching: 0** **Project, Tutorial, and Assessment: 0** **Total hours: 3**			
5	**Course Objective**	i. Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications ii. Explain direct metal laser sintering, LOM and fusion deposition modeling processes iii. Demonstrate solid ground curing principle and process iv. Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components v. Applying of measurement and scaling technique for prototype manufacturing.			
6	**Course Outcomes**	CO 1:Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications. CO 2: Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning. CO 3: Applying of measurement and scaling technique for prototype manufacturing. CO 4: Identify the Rapid Prototyping Data Formats CO 5: Application for powder based rapid prototyping systems			
7	**Outline syllabus:** Introduction, CAD Modelling and Data Processing for RP, RP Systems, Fusion Processes. Extrusion-Based RP Systems, Errors in RP Processes, RP Applications				
7.01	**Paper Code**	**Unit**	**Introduction**	**Reference number**	**Teaching methods**
	PCC-ME-405	(I)	Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.	Whiteboard, PPT slides, Tutorials, Demonstration
		(II)	CAD Modelling and Data Processing for RP: CAD model preparation, Data Requirements,	Chua C K, Leong K F, Chu S L, Rapid Prototyping:	Whiteboard, PPT slides, Tutorials,

			Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation	Principles and Applications in Manufacturing, World Scientific.	Demonstration
		(III)	RP Systems: Photo polymerization Stereo lithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photo polymerization Processes. Powder Bed Fusion: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.	Whiteboard, PPT slides, Tutorials, Demonstration
		(IV)	Fusion Processes. Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. 3D Printing : 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes. Sheet Lamination : Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam Deposition: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.	Whiteboard, PPT slides, Tutorials, Demonstration
		(V)	Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS. RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.	Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.	Whiteboard, PPT slides, Tutorials, Demonstration

8	**Course Evaluation**	
8.10	**CA: 20%**	
8.1	**Attendance**	10%
8.12	**Homework**	10%
8.13	**Quizzes**	-
8.14	**Projects**	-
8.15	**Presentation**	-
8.16	**Any other**	-
8.2	**MTE(IA)**	20%
8.3	**End-term examination: 60%**	
9	**Text Books & References**	
9.1	**Text books**	1. 1. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific. 2. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer. 3. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific. 4. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons. 5. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press
9.2	**References**	1.Upcraft, S., & Fletcher, R. (2003). The rapid prototyping technologies. *Assembly Automation*. 2. Yan, X., & Gu, P. E. N. G. (1996). A review of rapid prototyping technologies and systems. Computer-aided design, 28(4), 307-318. 3. Pham, D. T., & Gault, R. S. (1998). A comparison of rapid prototyping technologies. International Journal of machine tools and manufacture, 38(10-11), 1257-1287. 4. Pham, D. T., & Gault, R. S. (1998). A comparison of rapid prototyping technologies. International Journal of machine tools and manufacture, 38(10-11), 1257-1287. 5. Bourell, D. L., Beaman Jr, J. J., Klosterman, D., Gibson, I., & Bandyopadhyay, A. (2001). Rapid prototyping. ASM Handbook, 21, 383-7. 6. Ashley, S. (1991). Rapid prototyping systems. Mechanical engineering, 113(4), 34.
9.3	**Video References**	https://archive.nptel.ac.in/courses/112/104/112104265/ https://onlinecourses.nptel.ac.in/noc22_me74/preview

Mapping of Outcomes v. Topics

Course Outcome	**Program Outcome**												**PSO**			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	1	2	1	1	2	2	1	2	3	3	2	2
CO2	3	3	3	3	2	2	1	1	1	1	1	1	3	3	2	2
CO3	3	3	3	3	3	2	2	1	2	2	2	2	3	3	2	2
CO4	3	3	3	3	3	2	2	1	2	1	1	1	3	2	2	1
CO5	3	2	1	1	3	3	2	1	1	1	1	2	3	2	3	2

QUESTION BANK

1. Briefly explain the need for rapid prototyping.
2. Discuss the evolution of RP systems indicating the history and their growth rate in
3. the industrial sector
4. What is rapid prototyping? Give its advantages and limitations.
5. What are the materials used in rapid prototyping?
6. Classify rapid prototyping process.
7. List out applications of rapid prototyping.
8. Explain rapid tooling wheel.
9. Discuss the steps followed in rapid prototyping process.
10. Describe the role of RP in product development.
11. Describe the principle of working of Stereo lithography system.
12. What are its applications?
13. Discuss about photo polymerization.
14. What are the advantages and disadvantages of SLA?
15. What are the desirable features of Stereo lithography resin?
16. Discuss the suitable measures to reduce distortions in SLA process.
17. Explain the process details on the quality of product in SLA.
18. Explain the working principle and details of process parameters of an FDM
19. machine.
20. With neat sketches explain solid ground curing process and its advantages.
21. What are the disadvantages and applications of SGC system?
22. Explain in detail about laminated object manufacturing and its applications.
23. With an example explain path generation in FDM process.
24. What are the applications of FDM models? Give an example.
25. List the advantages and limitations of FDM.
26. What are the merits and demerits of LOM?
27. With neat sketch explain the process of selective laser sintering process and its
28. advantages, disadvantages and applications.
29. What are the materials used in SLS system.
30. Differentiate SLA and SLS in rapid prototyping
31. Describe laminated object manufacturing process and discuss the principle and
32. effect of process parameters on qualities of final product.
33. What are the materials suitable for FDM process?
34. Discuss the machine details of SGC.
35. Distinguish the following process: FDM, LOM, SGC and SLS.
36. List the various rapid prototype concept modelers
37. Explain how SLS process can be used to produce direct and in-direct prototypes.
38. Write short notes on: (i) Object Quadra system. (ii) Thermal jet printer.
39. What is rapid tooling and explain the applications of RPT in manufacturing and tooling.
40. What are concept modelers? Explain the applications of RP components from concept modelling.
41. Explain about the Sander's model maker and Object Quadra system
42. Explain the working principle of three-dimensional printing along with its advantages
43. Explain in detail about process details and machine details of 3-D printing
44. With neat sketch explain the model maker operation.
45. Discuss about multi jet modelling and its uses.
46. Write advantages and disadvantages of (i) Model maker.