INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**RAPID PROTOTYPE TECHNOLOGIES**				
Course Code	BCCB08				
Programme	M.Tech				
Semester	I				
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Course Faculty	Dr. G V R Seshagiri Rao, Professor, ME				

I. COURSE OVERVIEW:

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. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME510	VI	Additive Manufacturing techniques	3

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Rapid prototype technologies	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	LCD / PPT	✔	Seminars	✔	Videos	✔	MOOCs
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept
50 %	To test the application skill of the concept.

Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 1. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Technical Seminar and Term Paper	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:

Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Apply advanced level knowledge, techniques, skills and modern tools in the field of computer aided engineering to critically assess the emerging technological issues.	3	Presentation on Real-world problems
PO 2	Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.	2	Projects
PO 3	Conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.	2	Assignments
PO 4	Function on multidisciplinary environments by working cooperatively, creatively and responsibly as a member of a team.	1	Seminars
PO5	Write and present a substantial technical report / document.	3	Projects
PO6	Independently carry out research / investigation and development work to solve practical problems	2	Projects
PO7	Design and validate technological solutions to defined problems and recognize the need to engage in lifelong learning through continuing education.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
II	Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning
III	Applying of measurement and scaling technique for prototype manufacturing.

VIII. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.	CLO 1	Identify and understand of basic concepts of Rapid prototyping technologies
		CLO 2	Understand and Apply concepts of Rapid prototyping
		CLO 3	Classify the rapid prototyping systems
CO2	Identify The process photopolymers, photo polymerization, layering technology, laser and laser scanning.	CLO 4	Understand the different Models and specifications
		CLO 5	Understand the selection of manufacturing method
		CLO6	Identify the Layering Technology, Applications.
CO3	Applying of measurement and scaling technique for prototype manufacturing.	CLO 7	Understand the different models and specifications
		CLO 8	Classify the Rapid Tooling systems
		CLO 9	Understand the Powder Based Rapid Prototyping Systems
CO4	Identify the Rapid Prototyping Data Formats	CLO 10	Identify the Rapid Prototyping Data Formats
		CLO 11	Understand the Rapid Prototyping Software's
		CLO 12	Identify the Newly Proposed Formats

CO5	Application for powder based rapid prototyping systems	CLO 13	Application for powder based rapid prototyping systems
		CLO 14	Application in Design and Engineering
		CLO 15	Design and Production of Medical Devices, Forensic Science and Anthropology

3 = High; 2 = Medium; 1 = Low

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BCCB08.01	CLO 1	Identify and understand of basic concepts of Rapid prototyping technologies	PO 1	3
BCCB08.02	CLO 2	Understand and Apply concepts of Rapid prototyping	PO 1	3
BCCB08.03	CLO 3	Classify the rapid prototyping systems	PO 1,PO 2	3
BCCB08.04	CLO 4	Understand the different Models and specifications	PO 1,PO 2	2
BCCB08.05	CLO 5	Understand the selection of manufacturing method	PO 2	2
BCCB08.06	CLO 6	Identify the Layering Technology, Applications.	PO 1,PO 2,PO 3	2
BCCB08.07	CLO 7	Understand the different models and specifications	PO 2	1
BCCB08.08	CLO 8	Classify the Rapid Tooling systems	PO 2, PO 3	1
BCCB08.09	CLO 9	Understand the Powder Based Rapid Prototyping Systems	PO 2	2
BCCB08.10	CLO 10	Identify the Rapid Prototyping Data Formats	PO 1,PO 2	2
BCCB08.11	CLO 11	Understand the Rapid Prototyping Software's	PO 1,PO 2,PO 3	3
BCCB08.12	CLO 12	Identify the Newly Proposed Formats	PO 3, PO 6	3
BCCB08.13	CLO 13	Application for powder based rapid prototyping systems	PO 2, PO 6	3
BCCB08.14	CLO 14	Application in Design and Engineering	PO 3,PO 2	3
BCCB08.15	CLO 15	Design and Production of Medical Devices, Forensic Science and Anthropology	PO 3, PO 6	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

COs	Course Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						
CO 2	3		2				
CO 3	3	3	2				
CO 4	3	2	1		1	1	
CO 5		2			2	1	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	3						
CLO 2	3						
CLO 3	3	3					
CLO 4	3	2					
CLO 5		2					
CLO 6	2	2	2				
CLO 7		1					
CLO 8		1	1				
CLO 9		2					
CLO 10	2	2					
CLO 11			3				
CLO 12		3					
CLO 13		3	3				
CLO 14			1			1	
CLO 15						1	

3 = High; 2 = Medium; 1 = Low

XII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO3, PO5	SEE Exams	PO1, PO3, PO5	Seminar and Term Paper	PO1, PO2, PO3, PO5
Viva	-	Mini Project	-	Laboratory Practices	-

XIII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIV. SYLLABUS

UNIT-I	INTRODUCTION TO RAPID PROTOTYPING
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	**TYPES OF PROTOTYPING SYSTEMS**
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 Rapid Prototyping 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 AND TOOLING**
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 FORMAT**
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 Magic's, Mimics, Solid View, View Expert, 3 D View, Velocity 2 , Rhino, STL View 3 Data Expert and 3 D doctor.	
UNIT-V	**RAPID PROTOTYPING APPLICATIONS**
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:	
Chua C.K., Leong K.F, LIM C.S, "Rapid prototyping: Principles and Applications", World Scientific publication Edition, 2010.	
Reference Books:	
1. D.T Pham, S. S. Dony, "Rapid Manufacturing", Springer, 1st Edition, 2001. 2. Paul F Jacobs, "Rapid Prototyping & Manufacturing", Wohlers Associates, ASME Press, 1st Edition, 1996.	

XIV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topic Outcomes	Topic/s to be covered	Reference
1-3	Identify and understand of basic concepts of Rapid prototyping technologies	Introduction To Rapid Prototyping, Prototyping fundamentals, Historical Development	T1, R1

4-7	Understand and Apply concepts of Rapid prototyping	Advantages And Limitations Of Rapid Prototyping, Commonly Used Terms Classification Of RP Process, Rapid Prototyping Process Chain	T1
8-11	Apply the concepts of prototyping technology	Fundamental Automated Processes, Process Chain, Types Of Prototyping Systems, Liquid-Based Rapid Prototyping Systems	T1, R2, R1
12-16	Understand the selection of manufacturing method	Stereo Lithography Apparatus (Sla): Models And Specifications, Process Working Principle, Photopolymers, Photo polymerization	T1
17-20	Identify the Layering Technology, Applications.	Layering Technology, Laser And Laser Scanning, Applications, Advantages And Disadvantages, Case Studies, Solid Ground Curing (Sgc)	T1,R2
21-25	Understand the different models and specifications	Models And Specifications, Process, Working Principle, Applications, Solid-Based Rapid Prototyping Systems	T1, R1
26-29	Understand and apply the Laminated Object Manufacturing	Laminated Object Manufacturing (Lom), Models And Specifications Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1
30-33	Understand and apply the Fused Deposition Modeling	Fused Deposition Modeling (Fdm) Models And Specifications, Process, Working Principle, Applications, Advantages And Disadvantages, Case Studies.	T1, R1

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with Pos
1	To improve standards and analyze the concepts.	Seminars	PO 1
2	Concepts related to Additive Manufacturing	Seminars / NPTEL	PO 2,PO 3
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6,PO7

Prepared by:
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