INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**DESIGN FOR MANUFACTURING AND ASSEMBLY**				
Course Code	AME520				
Programme	B.Tech				
Semester	VIII	ME			
Course Type	**Professional Elective**				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. A Venuprasad, Assistant Professor, ME				
Course Faculty	Mr. A Venuprasad, Assistant Professor, ME				

I. COURSEOVERVIEW:

To provide an overview of Design for Manufacturingand Assembly (DFMA) techniques, which are used tominimize product cost through design and processimprovements. Design for Manufacturing (DFM) and Designfor Assembly (DFA) are now commonlyreferred to as a single methodology, DesignforManufacturing and Assembly (DFMA).Thiscoursebridgesgapbetweendesignandmanufacturing,it introducestheprinciplesof design for developing the product, which includes design considerations in casting, forging, metal forming and inwelding.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME006	IV	PRODUCTION ENGINEERING	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
DESIGN FOR MANUFACTURING AND ASSEMBLY	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Chalk & Talk	✓	Quiz	✓	Assignments	✗	MOOCs
✓	LCD / PPT	✓	Seminars	✗	Mini Project	✓	Videos
✗	Open Ended Experiments						

V. EVALUATIONMETHODOLOGY:

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.

SemesterEndExamination(SEE): TheSEEisconductedfor70marksof3hoursduration.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 aquestion.

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 OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for everycourse.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCsetc.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		Strength	Proficiencya ssessed by
PO 1	**EngineeringKnowledge**:Capabilitytoapplytheknowledgeof mathematics,scienceandengineeringinthefieldofmechanical engineering.	3	Assignments
PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at a relevant conclusion using knowledge of mathematics, science and engineering.	2	Mini project
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Industrial/ Seminars
PO 4	**Conduct investigations of complex problems:** To design and conductresearchorientedexperimentsaswellastoanalyzeand implement data using researchmethodologies.	2	Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiencya ssessed by
PSO 1	**Professional Skills:** To produce engineering professionalCapable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Assignments
PSO 2	**Problemsolvingskills**:Anabilitytoadoptandintegratecurrenttechnologies in the design and manufacturing domain to enhance theemployability.	-	Projects
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills tobecome technocrats.	-	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES(COs):

The course should enable the students to:	
I	Understand various general design rules for manufacture ability and criteria for material selection.
II	Apply various machining process and tolerance aspects in machining.
III	Analyze the design considerations for casting and welding process.
IV	Apply the conceptual design factors to be considered in forging, extrusion and sheet metal work,design guidelines for manual assembly and development of DFA methodology

IX. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Identifying primary and secondary components through functional analysis	CLO 1	Identify and understand of basic concepts of DFM and DFA
		CLO 2	Understand and Apply concepts of Generative DFMA
		CLO 3	Understand the Various types of materials, its classification, suitable materials for product design
CO 2	Calculate the design efficiency for their product design	CLO 4	Understand the selection of manufacturing sequences and optimal selection
		CLO 5	Identify the reasons for optimal selection of machining parameters.
		CLO 6	Identify the various casting design, machining design, designing of formed components
CO 3	Identy various design recommendation of design process	CLO 7	Identity various design recommendation for permanent joining such as welding, soldering and brazing
		CLO 8	understand the different design factors for forging, closed dies forging design
		CLO 9	Apply the different Design guidelines for extruded sections
		CLO 10	Understand various design principles for punching, blanking, bending, deep drawing.
CO 4	Analyze and derive the gripping,insertion and fixing values through fitting analysis of the product	CLO 11	Understand the different conventional approach and Assembly optimization processes
		CLO 12	Create the knowledge on cost consciousness & an awareness of Designers' accountability in product design lifecycle .
		CLO 13	Understand the cost factors that play a part in DFA
CO 5	Apply the Design guidelines and assembly techniques to mechanical designs.	CLO 14	Understand the general design guidelines for manual assembly and development of the systematic DFA methodology
		CLO 15	Using CAD, apply design for manufacturing and assembly techniques to mechanical designs.
		CLO 16	Understand the effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

X. COURSE LEARNING OUTCOMES(CLOs):

CLOCode	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME010.01	CLO 1	Identify and understand of basic concepts of DFM and DFA	PO 1, PO 4	3
AME010.02	CLO 2	Understand and Apply concepts of Generative DFMA	PO 3	2
AME010.03	CLO 3	Understand the Various types of materials, its classification, suitable materials for product design	PO 1, PO 4	3
AME010.04	CLO 4	Understand the selection of manufacturing sequences and optimal selection	PO 1	3
AME010.05	CLO 5	Identify the reasons for optimal selection of machining parameters.	PO 1, PO 4	3
AME010.06	CLO 6	Identify the various casting design, machining design, designing of formed components	PO 4	2

CLOCode	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME010.07	CLO 7	Identity various design recommendation for permanent joining such as welding, soldering and brazing	PO 3	2
AME010.08	CLO 8	understand the different design factors for forging, closed dies forging design	PO 4	2
AME010.09	CLO 9	Apply the different Design guidelines for extruded sections	PO 3	2
AME010.10	CLO 10	Understand various design principles for punching, blanking, bending, deep drawing.	PO 4	2
AME010.11	CLO 11	Understand the different conventional approach and Assembly optimization processes	PO 3	2
AME010.12	CLO 12	Create the knowledge on cost consciousness & an awareness of Designers' accountability in the product design lifecycle.	PO 2	2
AME010.13	CLO 13	Understand the cost factors that play a part in DFA	PO 3	2
AME010.14	CLO 14	Understand the general design guidelines for manual assembly and development of the systematic DFA methodology	PO 1,PO3	3
AME010.15	CLO 15	Using CAD, apply design for manufacturing and assembly techniques to mechanical designs.	PO 2	2
AME010.16	CLO 16	Understand the effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.	PO 2	2

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PSO 1	PSO 2	PSO 3
CO 1	3		2	2	3		
CO 2	3			2	3		
CO 3			2	2	3		
CO 4		2	2		3		
CO 5	3	2	2		3		

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3			2											
CLO 2			2										3		

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
CLO 3	3			2											
CLO 4	3														
CLO 5	3			2									3		
CLO 6				2											
CLO 7			2												
CLO 8				2											
CLO 9			2										3		
CLO 10				2											
CLO 11			2												
CLO 12		2											3		
CLO 13			2												
CLO 14	3		2												
CLO 15		2											3		
CLO 16		2													

3 = High; 2 = Medium; 1 = Low

XIII. ASSESSMENTMETHODOLOGIES–DIRECT

CIE Exams	PO 1, PO 3, PO4, PSO 1	SEE Exams	PO 1, PO 2 PO 3, PO4, PSO 1	Assignments	PO 1, PO4	Seminars	PO 1, PO4
Laboratory Practices		Student Viva	PO 1, PO4	Mini Project	PO 1, PO4	Certification	PO 1, PO4

XIV. ASSESSMENTMETHODOLOGIES-INDIRECT

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

XV. SYLLABUS

UNIT-I	INTRODUCTION	Classes:09
Introduction: Design philosophy steps in design process, general design rules for manufacturability, basic principles of design Ling for economical production, creativity in design; Materials selection of materials for design developments in material technology, criteria for material selection, material selection interrelationship with process selection process selection charts.		
UNIT-II	MACHINING PROCESS, CASTING	Classes:09

Machining process: Overview of various machining processes, general design rules for machining, dimensional tolerance and surface roughness, design for machining, ease of redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.		
UNIT-III	**METAL JOINING, FORMING**	**Classes:09**
Metal casting: Appraisal of various casting processes, selection of casting processes, general design considerations for casting, casting tolerances, use of solidification simulation in casting design, product design rules for sand casting Metal joining: Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints, design of brazed joints.		
UNIT-IV	**DESIGN FOR FORGING**	**Classes:09**
Forging, design factors for forging, closed dies forging design, parting lines of die drop forging die design general design recommendations. extrusion and sheet metal work: Design guidelines for extruded sections, design principles for punching, blanking, bending, deep drawing, Keeler Goodman forming line diagram, component design for blanking.		
UNIT-V	**DESIGN FOR ASSEMBLY AND AUTOMATION**	**Classes:09**
Design for assembly: General design guidelines for manual assembly, development of systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time.		
Text Books:		
1. Geoffrey Boothroyd, ―Assembly Automation and Product Design‖, Marcel Dekker Inc., NY,1st Edition, 2013. 2. George E, Dieter, ―Engineering Design - Material & Processing Approach‖, McGraw-Hill,2nd Edition, 2000. 3. Geoffrey Boothroyd, ―Hand Book of Product Design‖, Marcel and Dekken,1st Edition, 2013. 4. Geoffrey Boothroyd, Peter Dewhurst, Winston ―Product Design for Manufacturing and Assembly‖, CRC Press, 1st Edition, 2010.		
Reference Books:		
1. Geoffrey Boothroyd, ―Hand Book of Product Design‖, Marcel and Dekken,1st Edition, 2013. 2. Geoffrey Boothroyd, Peter Dewhurst, Winston ―Product Design for Manufacturing and Assembly,CRC Press, 1st Edition, 2010.		

XVI. COURSEPLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes	Reference
1-4	Introduction: Design philosophy steps in design process, general design rules for manufacturability	CLO 1	T1:1.7 R1:3.7
5-7	Basic principles of design Ling for economical production, creativity in design	CLO 2	T1:1.8 R1:3.12
8-10	Materials selection of materials for design developments in material technology,	CLO 3	T1:3.1 R1:3.13
11-14	Criteria for material selection, material selection interrelationship with process selection process selection charts.	CLO 3	T1:2.1 R1:4.2
15-16	Machining process: Overview of various machining processes, general	CLO 4	T1:3.3 R1:3.14
17-20	Design rules for machining, dimensional tolerance and surface roughness	CLO 4	T1:4.1 R1:4.4
21-23	Metal casting: Appraisal of various casting processes, selection of casting process,	CLO 5	T1:5.1 R1:5.2

24-26	General design considerations for casting, casting tolerances, use of solidification simulation in casting design, product design rules for sand casting.	CLO 6	T1:6.1 R1:7.2
27-28	Metal joining: Appraisal of various welding processes, factors in design of weldments, general design guideline.	CLO 7	T1:6.6 R:7.4
29-30	Pre and post treatment of welds, effects of thermal stresses in weld joints, design of brazed joints.	CLO 7	T1:6.11 R1:8.5
31-32	Forging, design factors for forging, closed dies forging design,	CLO 8	T1:7.1 R1:6.5
33-34	Parting lines of die drop forging die design general design recommendations	CLO 8	T1:8.1 R3:3.2
35	Extrusion and sheet metal work: Design guidelines for extruded sections, ,	CLO 9	T1:9.1 R3:3.4
36-37	Design principles for punching, blanking	CLO 9	T1:9.5 R3:4.4
38	Bending, deep drawing, Keeler Goodman forming line diagram,	CLO 10	T1:10.1 R3:5.3
39	Component design for blanking.	CLO 10	T1:10.4 R3:7.2
40-41	Assembly advantages: Development of the assemble process	CLO 11	T1:10.8 R3:7.6
42	Choice of assemble method assemble , advantages social effects of automation	CLO 12	T1:10.9 R3:7.7
43-44	Indexing mechanisms, and operator, paced free, transfer machine.	CLO 13	T1:10.10 R3:7.8
45-47	Design of manual assembly: Design for assembly fits in the design process	CLO 13	T1:15.1 R3:7.9
48-49	General design guidelines for manual assembly, development of the systematic DFA methodology	CLO 14	T1:13.5 R3:9.2
50-52	Assembly efficiency, classification system for manual handling,	CLO 14	T1:13.7 R3:9.4
53-55	Classification system for manual insertion and fastening, effect of part symmetry on handling time,	CLO 15	T1:13.8
56-57	Effect of part thickness and size on handling time, effect of weight on handling time	CLO 14	T1:13.6 R3:10.3
58-59	Parts requiring two hands for manipulation, effects of combinations of factors,	CLO 15	T1:13.9 R3:12.3
59-60	Effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.	CLO 16	T1:14.8 R3:12.6

XVII. GAPS INTHE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Assembly efficiency, classification system for manual handling	Industrial visits	PO1, PO2, PO4	PSO1
2	Design of manual assembly	Seminar/ industrial visit	PO4	PSO1
3	CADapplication in design for manufacturing and assembly	Seminar	PO3	PSO1

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