INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**AIRCRAFT MATERIALS AND PRODUCTION**				
Course Code	AAE005				
Programme	B.Tech				
Semester	IV	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. D Govardhan, Professor.				
Course Faculty	Mr. S.Devaraj, Assistant Professor. Mr. T Mahesh Kumar, Assistant Professor. Mr. R Suresh Kumar, Assistant Professor.				

I. COURSE OVERVIEW:

Production engineering is a combination of manufacturing technology with management science. The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way. Production engineering encompasses the application of castings, machining processing, joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixtures, and dies and mould design and material science and design of automobile parts and machine designing and manufacturing. Production engineering also overlaps substantially with manufacturing engineering and industrial engineering. In industry, once the design is realized, production engineering concepts regarding work-study, ergonomics, operation research, manufacturing management, materials management, production planning, etc., play important roles in efficient production processes. These deal with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated production methods and control systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS005	1	Engineering Chemistry	4
UG	AHS007	I	Applied Physics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Aircraft Materials and Production	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✔	Mini Project	✔	Videos
✘	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 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 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.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Seminars
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Micro Projects
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Assignments, Practical's

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Lecture, Assignments.
PSO 2	**Problem solving skills:** imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles	-	-
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand about traditional engineering materials like steel and iron material behavior, and to know the enhancement of material properties using heat treatment.
II	Remember the technical areas of aerospace engineering production techniques using casting, different types of casting processes used in aircraft production.
III	Understand methodology and experience of welding techniques and inspection of welding area s using NDT.
IV	Achieve basic engineering production techniques using lathe and various operations such as plane turning, threading, tapering and drilling.
V	Demonstrate knowledge in advancement in material production giving an example of composites and discuss the importance and applications of composites in aircraft industry.

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
AAE005.01	CLO 1	Understand the different phases of iron carbon diagram for manufacturing the different materials with different carbon content.	PO1	3
AAE005.02	CLO 2	Study different material properties and process of heat treatments- annealing, normalizing, hardening and tempering.	PO1	2
AAE005.03	CLO 3	Structure and properties of copper and aluminum and their alloys. Understand the corrosive protective methods for metals	PO2	2
AAE005.04	CLO 4	Discuss different casting procedures- sand casting, metal casting, investment casting, centrifugal casting, etc.	PO3	1
AAE005.05	CLO 5	Understand the procedure of welding processes like arc welding, gas welding, spot welding, Soldering and for different materials.	PO3	2
AAE005.06	CLO 6	Understand the different NDT testing procedures for metals and non-metals by using ultrasonic testing, radiography testing and magnetic particle testing	PO2	2
AAE005.07	CLO 7	Getting knowledge about the sheet metal techniques to produce different objects like punching, blanking, piercing, shearing, etc.	PO3	3
AAE005.08	CLO 8	Understand the concept of spinning, stretch forming and drawing of different materials.	PO1	2
AAE005.09	CLO 9	Understand the different fastening techniques riveting, tooling of aircraft by using jigs and fixtures.	PO2	2
AAE005.10	CLO 10	Gain knowledge about the basic convectional, unconventional riveting and welding for knowledge based exams.	PO3	1
AAE005.11	CLO 11	Getting knowledge to implement the chemical and electro chemical machining techniques.	PO5	2
AAE005.12	CLO 12	Understand the processes parameters of electrical energy based machining processes.	PO2	2
AAE005.13	CLO 13	Demonstrate a good understanding of types and properties of composites used in aircraft.	PO1	3
AAE005.14	CLO 14	Possess knowledge in processing and fabrication of structural composites.	PO5	3
AAE005.15	CLO 15	Understand mechanical behaviors of aircraft composite materials.	PO5	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO 1	3															
CLO 2	2												1			
CLO 3		2														
CLO 4			1										2			
CLO 5			2													
CLO 6		2														
CLO 7			3													
CLO 8	2															
CLO 9		2											2			
CLO 10			1													
CLO 11					2											
CLO 12		2														
CLO 13	3												1			
CLO 14					3											
CLO 15					2											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO2, PO3, PO5	SEE Exams	PO1, PO2, PO3, PO5	Assignments	PO1,PO5	Seminars	PO2
Laboratory Practices	PO1	Student Viva	-	Mini Project	PO3	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES – INDIRECT

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

XIII. SYLLABUS

Unit-I	AIRCRAFT ENGINEERING MATERIALS
Engineering materials Steels, study of iron, iron carbon phase diagram, heat treatment-annealing, normalizing, hardening and tempering of Aluminum and steel, Non-Ferrous metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Corrosion - Types of Corrosions - Prevention – Protective Treatments.	
Unit-II	**CASTING, WELDING AND INSPECTION TECHNIQUES**
General principles of various casting processes Sand casting, die-casting, centrifugal casting, investment casting, Shell molding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electron beam welding, soldering and brazing techniques. Need for NDT, ultrasonic testing, Radiographic testing, Flight testing.	
Unit-III	**SHEET METAL PROCESSES IN AIRCRAFT INDUSTRY**
Sheet metal operations: shearing, punching, super plastic forming; operations in bending like stretch forming spinning drawing. Riveting, types and techniques, equipment, fasteners, integral tanks, final assembly of aircraft, Jigs and Fixtures, stages of assembly, aircraft tooling concepts.	
Unit-IV	**CONVENTIONAL AND UNCONVENTIONAL MACHINING PROCESSES**
General working principles, applications and operations of lathe, shaper, milling machines, grinding, drilling machine, computer numeric control machining. Working principles and applications of abrasive jet machining, ultrasonic machining, Electric discharge machining and electro chemical machining, laser beam, electron beam, plasma arc machining.	
Unit-V	**AIRCRAFT COMPOSITES**
Introduction, Physical metallurgy, Wrought aluminum alloys, Cast aluminum alloys, Production of semi-fabricated forms, Aerospace applications, Plastics and rubber, Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins; Characteristics and applications, Classification of aircraft materials; Materials used for aircraft components, Application of composite materials, Super alloys, indigenized alloys, emerging trends in aerospace materials.	
Text Books:	
1. S. Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley 5th Edition, 1991. 2. S. C. Keshu, K. K Ganapathy, "Aircraft production technology and management", Interline Publishing House, Bangalore, 3rd Edition, 1993. 3. Douglas F. Horne, "Aircraft production technology", Cambridge University Press, 1st Edition, 1986.	
REFERENCES:	
1. S. C. Keshu, K. K Ganapathy, "Air craft production techniques", Interline Publishing House, Bangalore, 3rd Edition, 1993. 2. R. K. Jain, "Production Technology", McGraw-Hill, 1st Edition, 2002. 3. O. P. Khanna, M. Lal, "Production Technology", Dhanpat Rai Publications, 5th Edition, 1997.	

XIV. COURSE PLAN:

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

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Engineering materials Steels, study of iron	CLO1	T2:5.5 R1:1.12.1
3-5	Iron carbon phase diagram	CLO1	T2:5.6 R1:1.12.3
6-7	Heat treatment-annealing, normalizing, hardening and tempering	CLO1	T2:5.10

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
	of Aluminum and steel, Non-Ferrous metals and Alloys		R1:1.15
8-10	Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys,	CLO2	T2:5.15 R1:1.16
11-12	Corrosion - Types of Corrosions - Prevention – Protective Treatments	CLO2	T2:5.17 R1:1.13.1
13-14	General principles of various Casting Processes - Sand casting, die-casting, centrifugal casting, investment casting.	CLO2	T2:5.18 R2:1.13.2
15-16	shell molding types	CLO3	T2:5.19 R1:1.13.3
17-21	Principles and equipment used in arc welding, gas welding	CLO3	T2:5.20 R1:1.17.1
22-23	Laser welding , Electron beam welding	CLO4	T2:5.24 R1:1.17.3
24-25	Soldering and brazing techniques	CLO4	T2:6.1 R1:2.3
26-27	Need for NDT, ultrasonic testing, Radiographic testing	CLO5	T2:6.3 R1:2.6.1
28-30	Sheet metal operations-shearing	CLO5	T2:6.5 R1:2.6.2
31-32	punching, super plastic forming and diffusion bonding	CLO6	T2:7.3 R1:2.8
33-34	Different operations in bending like stretch forming spinning drawing etc.	CLO6	T2:7.5,7.6 R1:2.9.2
35-36	types of equipment for riveted joints	CLO7	T2:7.7 R1:2.10
37-39	Aircraft tooling concepts and Jigs and Fixtures	CLO7	T2:7.7 R1:2.10
40-41	General principles of working and types of lathe	CLO8	T2:7.11 R2:2.10.2
42-44	Shaper, milling machines, grinding, drilling m/c, CNC machining and general principles.	CLO9	T2:7.11 R1:2.32
45-48	Plane turning, threading, tapering, grooving, knurling and chamfering	CLO9	T2:15.2 R1:8.2
49-50	Importance of CNC and Advantages	CLO10	T2:15.7 R2:8.3.3
51-52	Principles (with schematic diagram only) of working and applications of abrasive jet machining,	CLO10	T2:15.13 R1:8.7.2
53-54	USM, EDM, ECM and LBM operations	CLO11	T2:5.20 R1:1.17.1
55-57	Satellite missions, an operational satellite system, elements of satellite, satellite bus subsystems	CLO11	T2:5.24 R1:1.17.3
58-60	Introduction, Physical metallurgy, Wrought aluminum alloys, Cast aluminum alloys, Production of semi-fabricated forms	CLO12	T3:6.1 R1:2.3
61	Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins.	CLO12	T2:6.3 R3:2.6.1
62-63	Characteristics and applications, Classification of aircraft materials;	CLO13	T2:6.5 R1:2.6.2
64-65	Materials used for aircraft components, Application of composite material	CLO13	T2:7.3 R1:2.8
67-66	Super alloys, indigenized alloys	CLO14	T3:7.5,7.6 R3:2.9.2
68	emerging trends in aerospace materials	CLO14	T3:7.7 R3:2.10

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Gain knowledge in unconventional machining process	Assignments	PO1,PO2	PSO1
2	Encourage students to make case studies on different advanced manufacturing methods	Seminars / Guest Lectures/ NPTEL	PO1,PO5	PSO1

Prepared by:

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