



COURSE PLAN

Name of the Faculty	Mr R.Rajeshkumar			
Designation/Department	Assistant Professor / Aerospace Engineering			
Course Code/Name	AC8005 / Aerospace Materials			
Year/Section/Department	IV / Aerospace Engineering			
Credits Details	L: 3	T: 0	P: 0	C: 3
Total Contact Hours Required	45			

SYLLABUS:

UNIT I	ELEMENTS OF AEROSPACE MATERIALS	9
<i>Structure of solid materials - Atomic structure of materials - crystal structure - miller indices - density - packing factor - space lattices - x-ray diffraction - imperfection in crystals -physical metallurgy - general requirements of materials for aerospace applications</i>		
UNIT II	MECHANICAL BEHAVIOUR OF MATERIALS	9
<i>Linear and non linear elastic properties - Yielding, strain hardening, fracture, Bauchinger's effect - Notch effect testing and flaw detection of materials and components - creep and fatigue - comparative study of metals, ceramics plastics and composites.</i>		
UNIT III	CORROSION & HEAT TREATMENT OF METALS AND ALLOYS	10
<i>Types of corrosion - effect of corrosion on mechanical properties - stress corrosion cracking - corrosion resistance materials used for space vehicles heat treatment of carbon steels - aluminium alloys, magnesium alloys and titanium alloys - effect of alloying treatment, heat resistance alloys - tool and die steels, magnetic alloys,</i>		
UNIT IV	CERAMICS AND COMPOSITES	9
<i>Introduction - powder metallurgy - modern ceramic materials - cermets - cutting tools - glass ceramic -production of semi fabricated forms - plastics and rubber - carbon/carbon composites, fabrication processes involved in metal matrix composites - shape memory alloys - applications in aerospace vehicle design, open and close mould processes.</i>		
UNIT V	HIGH TEMPERATURE MATERIALS CHARACTERIZATION	8
<i>Classification, production and characteristics - methods and testing - determination of mechanical and thermal properties of materials at elevated temperatures - application of these materials in thermal protection systems of aerospace vehicles - super alloys - high temperature material characterization.</i>		

COURSE OBJECTIVE:

The student should be made:

- *To study the types of mechanical behavior of materials for aircraft applications*

TEXT BOOK:

- *T1. Titterton.G., "Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 1995.*

REFERENCE:

- *R1. Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, New Delhi, 1993.*
- *R2. O.P.Khanna., "Materials science and Metallurgy", Dhanpat Rai Publications*

WEB RESOURCES:

- W1: <https://www.britannica.com/science/crystal/Structure>
- W2: <https://fractory.com/heat-treatment-methods/>
- W3: <https://www.aopa.org/go-fly/aircraft-and-ownership/maintenance-and-inspections/aircraft-corrosion>

ONLINE MODE OF STUDY:

- NPTEL : <https://nptel.ac.in/courses/113/102/113102080/>
- MIT OCW : <https://ocw.mit.edu/courses/materials-science-and-engineering/>

COURSE PLAN:

Topic No	Topic	Reference Detail	Page Number	Mode of teaching	Number of Periods Required	Cumulative Period
UNIT 1		ELEMENTS OF AEROSPACE MATERIALS				
1	Structure of solid materials	R2 W1	35.4 - 35.5	PPT	1	1
2	Atomic structure of materials	R2 W1	35.6 - 35.8	PPT	1	2
3	Crystal structure - miller indices	R2 W1	35.34 - 35.38	PPT	1	3
4	Density - packing factor	R2 W1	35.26 - 35.30	PPT	1	4
5	Space lattices	R2 W1	35.14 - 35.15	PPT	1	5
6	X-ray diffraction	R2 W1	35.44 -35.47	PPT	1	6
7	Imperfection in crystals	R2 W1	37.1 - 37.11	PPT	1	7
8	Physical metallurgy	R2 W1	35.1-35.2	SB	1	8
9	General requirements of materials for aerospace applications	R2 W1	4.2 - 4.7	SB	1	9

OUTCOMES:

At the end of unit, students should be able to

- Explain about the crystal structures and its application in aerospace.

UNIT 2		MECHANICAL BEHAVIOUR OF MATERIALS				
10	Linear and non linear elastic properties	W2	-	SB	1	10
11	Yielding, strain hardening	W2	-	PPT	1	11
12	Fracture,	R2	55.3 - 55.6	SB	1	12
13	Bauchinger's effect	R2	54.21-54.22	SB	1	13
14	Notch effect testing and flaw detection of materials and components	R2	49.10 -49.12	PPT	1	14
15	Creep	R2	55.19-55.25	PPT	1	15

16	Fatigue	R2	55.12-55.18	PPT	1	16
17	Comparative study of metals	R1	244 - 246	PPT	1	17
18	Ceramics plastics and composites.	R1	156 - 158	SB	1	18

OUTCOMES:

At the end of unit, students should be able to

- *Illustrate the metallurgical factor of materials over the temperature.*
- *Identify various hardening process on ductile and brittle materials.*

UNIT 3

CORROSION & HEAT TREATMENT OF METALS AND ALLOYS

19	Types of corrosion	T1 W3	120 -125	PPT	1	19
20	Effect of corrosion on mechanical properties	T1 W3	240 -244	SB	1	20
21	Stress corrosion cracking	T1 W3	122-123	SB	1	21
22	Corrosion resistance materials used for space vehicles heat treatment of carbon steels	T1 W3	124-126	PPT	1	22
23	Aluminium alloys	R2	11.2-11.3	PPT	1	23
24	Magnesium alloys and Titanium alloys	R2	6.11-6.13	PPT	1	24
25	Effect of alloying treatment	R2	40.9-40.11	PPT	1	25
26	Heat resistance alloys	R2	7.4-7.7	PPT	1	26
27	Tool and Die steels,	R2	8.1-8.3	PPT	1	27
28	Magnetic alloys,	R2	36.7-36.9	PPT	1	28

OUTCOMES:

At the end of unit, students should be able to

- *Interpret oxidation and hot corrosion.*

UNIT 4

CERAMICS AND COMPOSITES

29	Introduction - powder metallurgy	T1	263-265	PPT	1	29
30	Modern ceramic materials	T1	131-133	SB	1	30
31	Cermets - Cutting tools - Glass	T1	276-277	SB	1	31

	Ceramic					
32	Production of semi fabricated forms	<i>T1</i>	<i>147-148</i>	<i>PPT</i>	<i>1</i>	<i>32</i>
33	Plastics and Rubber	<i>T1</i>	<i>282-284</i>	<i>PPT</i>	<i>1</i>	<i>33</i>
34	Carbon/carbon composites	<i>T1</i>	<i>323-326</i>	<i>PPT</i>	<i>1</i>	<i>34</i>
35	Fabrication processes involved in metal matrix composites	<i>T1</i>	<i>315-317</i>	<i>SB</i>	<i>1</i>	<i>35</i>
36	Shape memory alloys	<i>T1</i>	<i>175-178</i>	<i>SB</i>	<i>1</i>	<i>36</i>
37	Applications in aerospace vehicle design, open and close mould processes.	<i>T1</i>	<i>185-187</i>	<i>SB</i>	<i>1</i>	<i>37</i>

OUTCOMES:

At the end of unit, students should be able to

- *Explain the composite materials and ceramic materials*

UNIT 5

HIGH TEMPERATURE MATERIALS CHARACTERIZATION

38	Classification	<i>R1</i>	<i>466-467</i>	<i>PPT</i>	<i>1</i>	<i>38</i>
39	Production and characteristics	<i>R1</i>	<i>473-475</i>	<i>PPT</i>	<i>1</i>	<i>39</i>
40	Methods and testing	<i>R1</i>	<i>493-495</i>	<i>PPT</i>	<i>1</i>	<i>40</i>
41	Determination of mechanical of materials at elevated temperatures	<i>R1</i>	<i>472-474</i>	<i>PPT</i>	<i>1</i>	<i>41</i>
42	Determination of thermal properties of materials at elevated temperatures	<i>R1</i>	<i>452-454</i>	<i>SB</i>	<i>1</i>	<i>42</i>
43	Application of these materials in thermal protection systems of aerospace vehicles	<i>R1</i>	<i>431-433</i>	<i>PPT</i>	<i>1</i>	<i>43</i>
44	Super alloys	<i>R2</i>	<i>6.16-6.19</i>	<i>PPT</i>	<i>1</i>	<i>44</i>
45	High temperature material characterization	<i>R2</i>	<i>7.1-7.4</i>	<i>PPT</i>	<i>1</i>	<i>45</i>

OUTCOMES:

At the end of unit, students should be able to

- *Utilize super alloys and ceramic material on high temperature.*

COURSE OUTCOMES:

At the end of course students should be able to do:

CO1: Explain about the crystal structures and its application in aerospace.

CO2: Illustrate the metallurgical factor of materials over the temperature.

CO3: Identify various hardening process on ductile and brittle materials. CO4: Interpret oxidation and hot corrosion.

CO5: Utilize super alloys and ceramic material on high temperature.

Course Outcome Vs Program Outcome Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1		1		1	1	1					
CO 2	1	1		1		1	1					
CO 3	1		1		1	1				1		
CO 4	1		1	1		1	1				1	
CO 5	1	1		1		1					1	1

CONTENT BEYOND THE SYLLABUS

- Fracture Maps For Different Alloys
- Phase diagram for metals

ASSIGNMENT

Assignment 1

Batch Details	Register Number	Total Number	Mode of Assignment	Topics
Batch 1	814918110001 - 009	09	PPT	Materials requirements for aerospace application
Batch 2	814918110010 - 020	09	MCQ	Unit-I&II.15MCQ from each unit
Batch 3	814918110021 - 029	08	Seminar	Testing methods of materials

Unit I & II.15 MCQ from each unit.

Assignment 2

Batch Details	Register Number	Total Number	Mode of Assignment	Topics
Batch 1	814918110001 - 009	09	MCQ	Unit-III&IV.15MCQ from each unit
Batch 2	814918110010 - 20	09	Seminar	Compare Metal, ceramics plastics and composites
Batch 3	814918110021 - 029	08	PPT	Alloy and its effects

Assignment 3

Batch Details	Register Number	Total Number	Mode of Assignment	Topics
Batch 1	814918110001 - 009	09	Seminar	Open and Close mould processes
Batch 2	814918110010 - 020	09	PPT	Composite and application
Batch 3	814918110021 - 029	08	MCQ	Unit V&I. 15 MCQ from each unit

SIM QUESTIONS:**SIM 1**

1. Classify solid materials based upon their atomic / crystalline structure and give the examples (MAY/JUNE 2016)
2. Explain the X-ray diffraction technique and explain its role in the study of materials (MAY/JUNE 2016)
3. Explain the structure of solid materials
4. Explain the different types of point defects (NOV/DEC 2016)
5. Explain about the crystallography miller indices.
6. Derive and show that the packing efficiency of FCC crystal structure is more than BCC crystal structure (NOV/DEC 2016)
7. List the general requirements of materials used in aerospace applications. (NOV/DEC 2016)
8. With the help of neat stress - strain curve, contrast the mechanical behavior of brittle and ductile material in a tensile test (MAY/JUNE 2016)
9. Explain the bauchinger effect in the mechanical behavior of a material (MAY/JUNE 2016)
10. Explain the following (i) Bauchinger's effect, (ii) strain hardening (NOV/DEC 2016)
11. What are the typical elastic constant of the mechanical behavior of a material
12. Draw and explain the linear and non linear curve for ductile and brittle

SIM 2

1. Explain the properties of ceramic materials
2. What are the various types of fracture? Classify the fracture on the basis of type of loading extent of deformation and appearance.
3. What are the structural changes involved during creep? Explain in detail.
4. Describe fatigue, its mechanism, its consequences and what can be done to the material in order to improve fatigue resistance.
5. Give a comparative study of materials used in aviation industries
6. Briefly explain the three steps of creep with a creep curve
7. What is super plasticity? Explain super plastic forming of aluminium alloys.
(MAY/JUNE 2016)
8. Describe different heat treatment processes available for aluminium alloys and state their respective purposes. (MAY/JUNE 2016)
9. Write short note on the following topics
 - i.C orrosion and different types of corrosion ii.S tress corrosion cracking
 - iii.C orrosion resistance materials used for air and space vehicles and their properties (MAY/JUNE 2016)
10. Explain the various types of corrosion that occurs in metallic materials. (NOV/DEC 2016)
11. Discuss the hardening and normalizing heat treatment processes that are applied to carbon steels. (NOV/DEC 2016)
12. What are the effect of corrosion on mechanical properties of materials? (NOV/DEC 2016)

SIM 3

1. Describe the shape memory effect and give examples of shape memory alloys
(MAY/JUNE 2016)
2. List a few examples of the use of metal matrix composite materials in air/space vehicles. Explain a fabrication process for a metal matrix composite part (MAY/JUNE 2016)
3. What do you mean by composites and the classification of composites?

4. Explain the open mould process of composite materials (MAY/JUNE 2016)
5. Explain the close mould process of composite materials (MAY/JUNE 2016)
6. How is high temperature materials classified? And explain the methods of production. (NOV/DEC 2016)
7. Discuss the various methods employed to determine the mechanical properties of materials at high temperature. (NOV/DEC 2016)
8. Explain strengthening of cobalt-base super alloys.
9. Briefly explain the major phases of nickel-base alloys
10. Analyze how the processing parameters can influence the mechanical properties of super alloys at high temperatures.
11. Explain the different types of alloying and effects alloy treatment
12. Explain in detail about the factors influencing functional life of components at elevated temperatures.

Submission Details:

Phase 1 (Before AT 1)		Phase 2 (Before AT 2)		Phase 3 (Before AT 3)	
Assignment 1	SIM 1	Assignment 2	SIM 2	Assignment 3	SIM 3

Google Class Code Details:gyhqely



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