COURSE CODE	COURSE TITLE	L	T	P	C
1152AE124	HIGH TEMPERATURE MATERIALS	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

To understand the structure, properties and behavior of materials on elevated temperature and to gain knowledge in the selection of suitable materials for various engineering applications.

b. Prerequisites :

- Strength of Materials
- Aero engineering thermodynamics

c. Links to other courses:

- Composite Materials and Structures
- Heat Transfer

d. Course educational objectives :

Students undergoing this course are expected to:

- Enrich knowledge of various behavior and property changes inside the material structure in raised temperature and methods to strengthening the material
- Provide in-depth proficiency in Material science and engineering fields and use appropriate mechanical testing methods and standards for material property evaluation in an interdisciplinary approach.

e. Course outcomes :

On the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand and describe the properties of material under constant load at elevated temperature.	K2
CO2	Have knowledge in improving material strength against high temperature environment and predict life time.	K3
CO3	Explain the types of fracture mechanisms for various materials and alloys	K2
CO4	Discuss oxidation and corrosion effect on materials due to elevated temperature	K4
CO5	Explains the properties of super alloys and its hardening processes	K5

(K1 – Remember; **K2** – Understand; **K3** – Apply K4-Analyze, K5 – Evaluate, K6 - Create)

f. CORRELATION OF CO'S WITH PROGRAMME OUTCOMES :

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1		H			H	L			H	M	L	L
CO2		H		L	H				L		L	L
CO3		H	L	L	H				L		L	L
CO4	L	H	L	H	H				L		L	
CO5	H	H	L	L	H				H	L	L	L

H- High; M-Medium; L-Low

f. Course contents :

UNIT I CREEP **L - 9**

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. components – case study.

UNIT II DESIGN FOR CREEP RESISTANCE **L - 9**

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT III FATIQUE AND FRACTURE **L - 9**

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, and ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides**.**

UNIT IV OXIDATION AND HOT CORROSION **L - 9**

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion**.**

UNIT V SUPER ALLOYS AND OTHER MATERIALS **L - 9**

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, High temperature ceramics-Smart materials

Total Periods :(L-45+T-0) =45

h. TEXT BOOKS :

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
2. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.

i. REFERENCES:

1. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.
2. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
3. McLean D., "Directionally Solidified Materials for High Temperature Service", the Metals Society, USA, 1985.