COURSE CODE	COURSE TITLE	L	T	P	C
1152AE123	HIGH TEMPERATURE GAS DYNAMICS	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course deals with the influence of high temperatures on both inviscid and viscous flow

b. Prerequisite Courses:

- Compressible flow Aerodynamics

c. Related Courses:

d. Course Educational Objectives :

Students undergoing this course are expected

- To know the basic concepts involved in high temperature flows
- To have fundamental understanding of microscopic thermodynamics and kinetic theory of gases
- To learn the equilibrium and non-equilibrium conditions in inviscid hypersonic flows and the salient aspects of transport phenomena in high temperature gases.

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the nature of high temperature and their effects on fluid flows	K2
CO2	Express a fundamental microscopic understanding of thermodynamics, temperature, radiation and transport phenomena	K2
CO3	Describe physical basis for the kinetic theory of gases	K2
CO4	Discuss the equilibrium and non-equilibrium conditions in inviscid hypersonic flows	K2
CO5	Explain the salient aspects of transport phenomena in high-temperature gases	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			**H**				H				
CO2	H			**H**				H				
CO3	H			**H**				H				
CO4	H			**H**				H				
CO5	H			**H**				H				

H- High; M-Medium; L-Low

f. Course Contents :

UNIT-I INTRODUCTION L-9

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non-equilibrium – Chemically reacting mixtures and boundary layers

UNIT-II STATISTICAL THERMODYNAMICS L- 9

Introduction to statistical thermodynamics – Relevance to hypersonic flow – Microscopic description of gases – Boltzmann distribution – Partition function

UNIT-III KINETIC THEORY AND HYPERSONIC FLOWS L-9

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions

UNIT-IV INVISCID HIGH TEMPERATURE FLOWS L-9

Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non-equilibrium inviscid flows.

UNIT-V TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES L-9

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases.

Total: 45 Periods

Learning Resources

i. Text Books:

1. John. D. Anderson. Jr, "Hypersonic and High Temperature Gas Dynamics", 2nd edition, AIAA education series, 2006.

ii. References:

1. John J. Bertin, "Hypersonic Aerothermodynamics", AIAA education series, 1994.
2. John. D. Anderson. Jr, "Modern Compressible Flow: With Historical Perspective", 3rd edition, Mcgraw Hill, 2004.
3. W. Heiser, D. Pratt, D. Daley, , U. Mehta, "Hypersonic Air breathing Propulsion", AIAA education series, 1994
4. TaritK.Bose, "High Temperature Gas Dynamics: An Introduction for Physicists and Engineers",2nd edition, Springer,2014
5. W. G. Vincenti, Charles H. Kruger, "Introduction to Physical Gas Dynamics", Krieger Pub Co, 1975
6. EthirajanRathakrishnan, "High Enthalpy Gas Dynamics" 1st edition, John Wiley & Sons, 2015