COURSE CODE	COURSE TITLE	L	T	P	C
1152AE125	HYPERSONIC AERODYNAMICS	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This Course provides knowledge on importance and properties of hypersonic flow. Hypersonic shock and expansion-wave relations. Local surface inclination methods. Approximate and exact methods for hypersonic inviscid flow fields. Viscous flow: boundary layers, aerodynamic heating, hypersonic viscous interactions.

b. Prerequisite Courses:

- Compressible flow Aerodynamics

c. Related Courses:

- Nil

d. Course Educational Objectives :

Students undergoing this course are expected

- To learn the fundamentals of hypersonic flows
- To develop approximate relations for inviscid flow over hypersonic vehicles.
- To develop approximate relations for boundary-layer flows over hypersonic vehicles.
- To have knowledge about viscous interaction in hypersonic flows.

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	Describe the fundamentals concept of hypersonic flows and their relations	K2
CO2	Develop approximate relations for inviscid flow over hypersonic vehicles	K3
CO3	Explain the approximate methods for inviscid hypersonic flows	K2
CO4	Develop approximate relations for boundary-layer flows over hypersonic vehicles	K3
CO5	Explain the viscous interactions in hypersonic flows	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 BASICS OF HYPERSONIC AERODYNAMICS L-9

Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows

UNIT-II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS L- 9

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties

UNIT-III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS` L-9

Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory - entropy effects - rotational method of characteristics - Hypersonic shock wave shapes and correlations.

UNIT-IV VISCOUS HYPERSONIC FLOW THEORY L-9

Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non-similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating**.**

UNIT-V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS L-9

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

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. R. N. and L. F. Crabtree Cox, "Elements of Hypersonic Aerodynamics" Academic Press, 1965
2. John J. Bertin, "Hypersonic Aerothermodynamics", AIAA education series, 1994.
3. John. D. Anderson. Jr, "Modern Compressible Flow: With Historical Perspective", 3rd edition, Mcgraw Hill, 2004.
4. John J. Bertin, Russell M. Cummings, Aerodynamics for Engineers, 6thedition,Prentice Hall, 2013
5. Ernst Heinrich Hirschel, "Basics of Aerothermodynamics", 2nd edition, Springer, 2015
6. W. Heiser, D. Pratt, D. Daley, , U. Mehta, "Hypersonic Air breathing Propulsion", AIAA education series, 1994
7. Wallace D. Hayes and Ronald F. Probstein, "Hypersonic Flow Theory", Academic Press Company, 1959
8. Wallace D. Hayes and Ronald F. Probstein, "Hypersonic Inviscid Flow", Dover Publications,2004
9. W. Hankey, "Re-Entry Aerodynamics", AIAA education series, 1988