BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTECH **SEMESTER : II**
BRANCH: SER **SESSION : SP/2025**

SUBJECT: SR580 ELEMENTS OF HYPERSONIC FLIGHT

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Define the shock layer in hypersonic flow and explain its significance. How do the shock layer and entropy layer affect the aerodynamic heating of a hypersonic vehicle?	[5]	1	2
Q.1(b)	What are high-temperature effects in hypersonic flows, and why are they important? Discuss how these effects influence the design and performance of hypersonic flight vehicles.	[5]	1	1,2
Q.2(a)	Explain the concept of the Modified Newtonian Law in hypersonic aerodynamics. How does it improve upon the classical Newtonian theory for predicting surface pressure?	[5]	2	3
Q.2(b)	Discuss the need for centrifugal force corrections in Newtonian theory for hypersonic flow. How does the curvature of the surface affect the pressure distribution, and how is this accounted for in the corrected model?	[5]	2	3
Q.3(a)	Apply the Hypersonic Equivalence Principle to a practical hypersonic flow scenario. How does this principle help simplify the analysis of flow over a blunt body, and what impact does it have on shock layer characteristics and pressure distribution?	[5]	3	3,4
Q.3(b)	Analyze the assumptions involved in the Hypersonic Small-Disturbance Theory. How do these assumptions affect the accuracy of the theory in predicting flow behavior around bodies at hypersonic speeds? Discuss the limitations and applicability of this theory in real-world hypersonic flight conditions.	[5]	3	4
Q.4(a)	Apply the governing equations for viscous flow (Navier-Stokes) to a hypersonic flow scenario over a flat plate. How do the boundary layer equations simplify under hypersonic conditions, and how would you determine the effect of these simplifications on the aerodynamic heating at the surface?	[5]	4	4
Q.4(b)	Analyze the role of similarity parameters in the boundary layer equations for hypersonic flow. How do these parameters help in scaling and solving the equations for different flow conditions?	[5]	4	3
Q.5(a)	Write the Navier Stokes equation for a three dimensional, unsteady, compressible viscous flow. Mention all the nomenclature.	[5]	5	1,2
Q.5(b)	With a neat diagram, discuss the shockwave boundary layer interaction phenomena.	[5]	4,5	2

::::::01/05/2025::::::E