Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE008

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - II

B.Tech V Semester End Examinations, November - 2019

Regulations: R16

HIGH SPEED AERODYNAMICS

(AERO)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1.	a)	Derive the pressure, density and temperature ratio along a streamline in isentropic flow with suitable diagram.	**[7M]**
	b)	An aircraft is flying at a speed of 1000 kmph. Compute the variations in speed of sound *a*, and Mach number *M* with altitude change from sea level and at 11 Km.	**[7M]**
2.	a)	Write short note on first law of thermodynamics and derive the energy equation in differential form.	**[7M]**
	b)	Consider airplane flying at an altitude of 20,000m. The pressure at a point on the wing is 19152N/m^2, assuming isentropic flow over the wing, calculate the temperature at this point?	**[7M]**

UNIT – II

3.	a)	Derive the expression for density relationship for normal shock for a perfect gas in terms of Mach number.	**[7M]**
	b)	Calculate the lift and drag coefficients for a flat plate at 50 angle of attack in a Mach 3 flow.	**[7M]**
4.	a)	Explain the theta-Beta-Mach relation for wide range of supersonic flow with suitable diagram.	**[7M]**
	b)	A Mach 2 air stream passes over a 10◦ expansion corner. Find the Mach number of the flow downstream of the expansion fan. Which expansion corner will produce Mach number 2.5?	**[7M]**

UNIT – III

5.	a)	Explain about choked flow, ideally expanded, over-expanded, under expanded flows in detail.	**[7M]**

b) Calculate the mass flow through the nozzle assuming that reservoirs temperature is 288K and throat area is 0.3 m^2. **[7M]**

6. a) Explain about variation of flow properties when heat is added to subsonic and supersonic flow. **[7M]**

b) What is the reservoir pressure for the tunnel if the nozzle of a supersonic wind tunnel has an exit to throat area ratio of 6.79 when the tunnel is running, a pitot tube mounted in the test section, measures 1.448 atm. **[7M]**

UNIT – IV

7. a) Write Short notes on "elements of finite-difference methods". High light the physical planes and computational planes. **[7M]**

b) At a given point on the surface of the aerofoil, the pressure coefficient is -0.3 at very low speed. If the free stream Mach number is 0.6, calculate C_p at this point. **[7M]**

8. a) Briefly explain about critical Mach number, Drag Divergence and Mach number with its relations. **[7M]**

b) For certain aerofoil at given point on the upper surface of the aerofoil, the pressure coefficient is -0.27 at very low speed. If the free stream Mach number is 0.75, calculate C_p and C_m at this point. **[7M]**

UNIT – V

9. a) Give a brief outline of operation of supersonic wind tunnels employing convergent - divergent nozzles? **[7M]**

b) What is the reservoir pressure for the tunnel if The nozzle of a supersonic wind tunnel has an exit to throat area ratio of 6.79 when the tunnel is running, a pitot tube mounted in the test section, measures 1.448 atm. **[7M]**

10. a) Define flow visualization. List the different types of flow visualizations available for compressible flow? **[7M]**

b) What are the essential conditions to be satisfied for the results to be carried from the model to the prototype? Are there any limitations or preconditions involved? **[7M]**

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COURSE OBJECTIVES:
The course should enable the students to:

I	Understand the effect of compressibility at high-speeds and the ability to make intelligent design decisions.
II	Explain the dynamics in subsonic, transonic and supersonic flow regimes in both internal and external geometries.
III	Analyze the airfoils at subsonic, transonic and supersonic flight conditions using the perturbed flow theory assumption.
IV	Formulate appropriate aerodynamic models to predict the forces and performance of realistic three dimensional configurations.

COURSE OUTCOMES (COs):

CO 1	Explain a brief review of thermodynamics and fluid mechanics in relation to compressible flows
CO 2	Demonstrate different types of shock waves and expansion waves and its properties across different situations.
CO 3	Demonstrate different types of shock waves and expansion waves and its properties across different situations.
CO 4	Illustrate the concepts of method of characteristics and its applications in nozzle designs.
CO 5	Understand the experimental methods and their characteristics of various wind tunnels.

COURSE LEARNING OUTCOMES (CLOs):

AAE008.01	Demonstrate the concept of supersonic flow, how it is different from incompressible flow.
AAE008.02	Understand governing equations of supersonic flow in various form and thermodynamics properties.
AAE008.03	Describe the governing equations required for compressible flows.
AAE008.04	Illustrate the impact of supersonic flow in the presence of compression and expansion corner.
AAE008.05	Demonstrate supersonic aircraft design and applications to aircrafts, supersonic wind tunnel, shock tubes.
AAE008.06	Understand the concepts of shock wave boundary layer interaction.
AAE008.07	Illustrate the concepts of quasi one dimensional flow for compressible flows.
AAE008.08	Describe isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slipstream line.
AAE008.09	Understand the impact of heat and Friction in duct flow and fanno flow.
AAE008.10	Describe small perturbation equations for subsonic, transonic, supersonic and hypersonic flow.
AAE008.11	Understand experimental characteristics of airfoils in compressible flow, supercritical airfoils and area rule.
AAE008.12	Explain supersonic nozzle design using method of characteristics.

AAE008.13	Illustrate working principle of subsonic wind tunnels, supersonic wind tunnels, shock tunnels.
AAE008.14	Explain free-piston shock tunnel, detonation-driven shock tunnels, and expansion tubes and characteristic features, their operation and performance.
AAE008.15	Demonstrate flow visualization techniques for compressible flows.

MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	AAE008.02	Understand governing equations of supersonic flow in various form and thermodynamics properties.	CO 1	Remember
	b	AAE008.01	Demonstrate the concept of supersonic flow, how it is different from incompressible flow.	CO 1	Understand
2	a	AAE008.02	Understand governing equations of supersonic flow in various form and thermodynamics properties.	CO 1	Understand
	b	AAE008.02	Understand governing equations of supersonic flow in various form and thermodynamics properties.	CO 1	Remember
3	a	AAE008.05	Demonstrate supersonic aircraft design and applications to aircrafts, supersonic wind tunnel, shock tubes.	CO 2	Remember
	b	AAE008.04	Illustrate the impact of supersonic flow in the presence of compression and expansion corner	CO 2	Remember
4	a	AAE008.04	Illustrate the impact of supersonic flow in the presence of compression and expansion corner	CO 2	Remember
	b	AAE008.04	Illustrate the impact of supersonic flow in the presence of compression and expansion corner	CO 2	Remember
5	a	AAE008.08	Describe isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slipstream line.	CO 3	Remember
	b	AAE008.08	Describe isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slipstream line.	CO 3	Remember
6	a	AAE008.09	Understand the impact of heat and Friction in duct flow and fanno flow	CO 3	Understand
	b	AAE008.07	Illustrate the concepts of quasi one dimensional flow for compressible flows	CO 3	Understand
7	a	AAE008.12	Explain supersonic nozzle design using method of characteristics.	CO 4	Remember
	b	AAE008.11	Understand experimental characteristics of airfoils in compressible flow, supercritical airfoils and area rule.	CO 4	Understand
8	a	AAE008.11	Understand experimental characteristics of airfoils in compressible flow, supercritical airfoils and area rule.	CO 4	Understand
	b	AAE008.11	Understand experimental characteristics of airfoils in compressible flow, supercritical airfoils and area rule.	CO 4	Remember
9	a	AAE008.13	Illustrate working principle of subsonic wind tunnels, supersonic wind tunnels, shock tunnels	CO 5	Understand
	b	AAE008.13	Illustrate working principle of subsonic wind tunnels, supersonic wind tunnels, shock tunnels	CO 5	Remember
10	a	AAE008.15	Demonstrate flow visualization techniques for compressible flows.	CO 5	Understand
	b	AAE008.13	Illustrate working principle of subsonic wind tunnels, supersonic wind tunnels, shock tunnels	CO 5	Understand

Signature of Course Coordinator **HOD, AE**