Register Number:……………..

KUMARAGURU
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B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

Fifth Semester

AERONAUTICAL ENGINEERING

U18AET5101**:** High Speed Aerodynamics

(Use of Gas Tables Permitted)

<u>COURSE OUTCOMES</u>

CO1: Use Basic Principles of the compressible gas flow.
CO2: Calculate the parameters of compressible flow through variable area duct.
CO3: Solve the problems on one dimensional flow with Normal shock, Rayleigh and Fanno flows and apply method of characteristics.
CO4: Examine the flow with Oblique shocks and Expansion waves.
CO5: Apply Linearized flow theory for streamlined bodies.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1.	Define isentropic compressibility.	CO1	[K_1]
2.	State the principle of the sound wave.	CO1	[K_1]
3.	Show the integral form of the momentum equation.	CO2	[K_1]
4.	List the characteristics of compressible flow.	CO2	[K_1]
5.	Compare Rayleigh with Fanno flows.	CO3	[K_2]
6.	Show the Hugoniot curve.	CO3	[K_1]
7.	Define the strength of a shock wave and the shocks of vanishing strength.	CO4	[K_1]
8.	Explain the development of boundary layer over a flat plate.	CO4	[K_2]
9.	List any two advantages of a swept back wing.	CO5	[K_1]
10.	State the significance of small perturbation theory.	CO5	[K_1]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11.	a)	Explain the Area-velocity relation of a convergent-divergent nozzle.	10	CO1	[K_2]
	b)	Compare the results of the Area-Velocity relation for convergent duct and divergent duct for subsonic and supersonic flow conditions.	6	CO1	[K_2]

12.		A De Laval nozzle has to be designed for an exit Mach number of 1.5 with an exit diameter of 200 mm. Find the required ratio of the throat area to the exit area. The reservoir conditions are given as $P_0 = 1$ atm, $T_0 = 20^\circ$ C. Find also the maximum mass flow rate through the nozzle. Find the exit pressure and temperature.	16	CO2	[K_4]
13.	a)	Show Prandtl relation for normal shock and also infer the findings of it.	12	CO3	[K_2]
	b)	A gas flow with velocity 400 m/s and specific volume 1.11 m^3/kg passes through a normal shock. If the specific volume behind the shock is 0.333 m^3/kg, solve the pressure increase caused by the shock.	4	CO3	[K_3]
14.	a)	Explain the salient features of shock polar.	8	CO4	[K_2]
	b)	A gas (γ=1.3) at P_1=345 mbar, T_1 = 350 K and M_1 = 1.5 is to be isentropically expanded to 138 mbar. Find the following:			
		1. Deflection angle	3		
		2. Final Mach number	3	CO4	[K_4]
		3. Final temperature of gas	2		
15.	a)	Illustrate the Prandtl Meyer expansion around the corner.	4	CO4	[K_2]
	b)	Show the expression of Prandtl Meyer function with the help of governing equations.	12	CO4	[K_2]
16.	a)	Explain the variation in aircraft performance with and without area rule with a neat sketch.	6	CO5	[K_2]
	b)	Develop the linearized perturbation velocity potential equation for a slender body with suitable assumptions.	10	CO5	[K_3]

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