DHANALAKSHMI SRINIVASAN
COLLEGE OF ENGINEERING AND TECHNOLOGY
MAMALLAPURAM, CHENNAI

DEPARTMENT OF AERONAUTICAL ENGINEERING

COURSE FILE

COURSE CODE	:	**C303**
SUBJECT CODE	**:**	**AE8503 (Regulation 2017)**
SUBJECT NAME	**:**	**AERODYNAMICS – II**
YEAR / SEMESTER	**:**	**III / V**

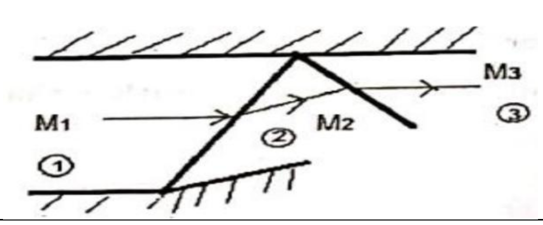
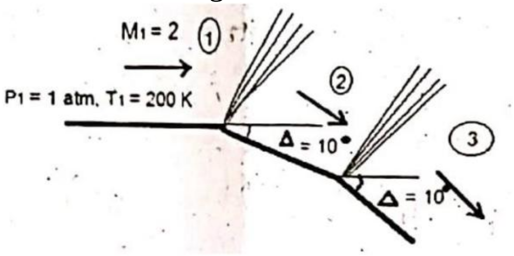
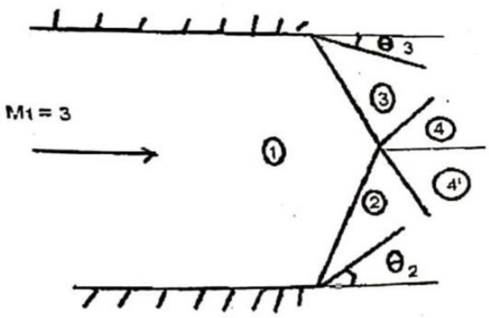
QUESTION BANK

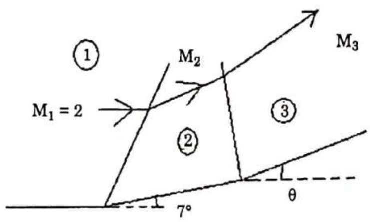
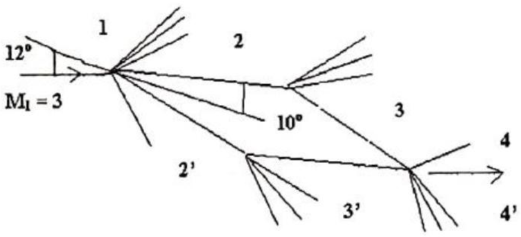
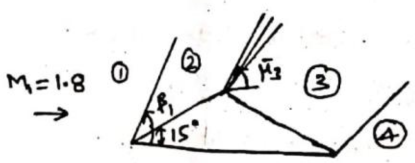
Subject Code & Name : AE8503 – Aerodyanmics II

Year / Sem :III / VI

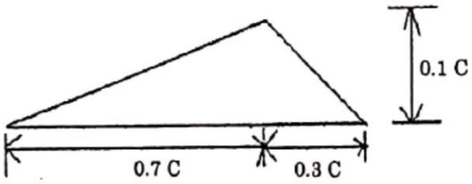
S.No	Question	BT Level
1	What is isentropic and isothermal compressibility	Understanding
2	Define characteristic Mach number and what is the maximum value of it	Remembering
3	Distinguish between thermally perfect gas and calorically perfect gas?	Remembering
4	Why is a convergent divergent nozzle required to expand a flow from stagnationcondition to supersonic velocity	Remembering
5	Explain the phenomenon of choking in a nozzle	Remembering
6	Define nozzle efficiency in terms of enthalpies?	Remembering
7	Write the one-dimensional energy equation for an adiabatic compressible steadyflow	Remembering
8	Write down the Bernoulli’s equation for compressible flow	Remembering
9	Write the Area Mach number relation?	Remembering
10	Derive the relation $\frac{\square 0}{} = [1 + (\frac{\square - 1}{})]\ \square^{2}$	Understanding
	Part B	
11	Derive an expression which relates Area-Velocity-Mach number. And discuss the important information behind the relationship	Apply
12	Starting from energy equation for adiabatic flow derive a relation between flow Mach number and characteristic Mach number	Apply
13	Describe the performance of nozzles under various back pressures	Understanding
14	Air flows isentropically through a convergent Divergent nozzle nozzle of inlet area 12 cm2 at a rate of 0.7kg/s. The conditions at inlet and exit of the nozzle are 8 kg/m3 and 400 K and 4 kg/m3 and 300 K respectively. Find the cross sectional area,pressure and Mach number at the exit	Apply
15	Air is expanded through a convergent Divergent nozzle from a large reservoir in which the pressure and temperature are 600 kPa and 40° C, respectively. The design back pressure is 100 kPa. Find (i) the ratio of the nozzle exit area to the nozzle throat area, (ii) the discharge velocity from the nozzle under design considerations (iii) At what back pressure will there be a normal shock at the exit plane of the	Apply

	nozzle	
16	Air flows through a nozzle which has inlet area of 10 cm2. If the air has a velocity of 80 m/s, a temperature of 28°C and a pressure of 700 kPa at the inlet section and a pressure of 250 kPa at the exit, find the mass flow rate through the nozzle and assuming one dimensional isentropic flow the velocity at the exit section of the nozzle	Apply
17	Consider adiabatic air flow through a duct. At a certain section of the duct, the flow area is 0.2 m2, the pressure is 80 kPa, the temperature is 5°C and the velocity is 200m/s, if at this section the duct area is changing at a rate of 0.3 m2/m. find dp/dx, dV/dx and dρ/dx.Assuming incompressible floe and taking compressibility into account.	Apply
18	What is mean by De-Laval nozzle? Derive the relation between Area and Mach number	Apply
19	A De Laval Nozzle has to be designed for an exit Mach number of 1.5 with exit diameter of 200mm. Find the ratio of throat area to exit area necessary. The reservoir conditions are given as P0 = 1 atm; T0 = 200C. Find also the maximum mass flow rate through the nozzle. What will be the exit pressure and temperature	Apply
20	Air flows through a duct. The pressure and temperature at station 1 are P1 = 0.7 atm and T1 = 300C, respectively. At a second station, the pressure is 0.5 atm. Calculate the temperature and density at the second station. Assume the flow to be isentropic	Apply
	Unit II	
1	Explain why shocks cannot occur in subsonic flows	Remembering
2	Explain zone of action and zone of silence for a body moving at a speed of sound?	Remembering
3	What is the need for a correction to the Pitot static tube readings in supersonic flowand write Rayleigh supersonic Pitot formula?	Understanding
4	How is flow over a cone different from flow over a wedge?	Remembering
5	Give the oblique shock relation in terms of flow angle and wave angle	Understanding
6	What is shock polar? Draw the shock polar for different Mach numbers?	Remembering
7	Define pressure turning angle and Hodograph Plane?	Remembering
8	Define the strength of a shock wave? Explain the shocks of vanishing strength?	Remembering
	Part B	
9	Derive Rankine-Hugonoit equation pressure density relationship for the shock wave and explain its significance	Understanding
10	Derive Prandtl relation for normal shock and explain its significance	Understanding
11	A shock wave across which the pressure ratio is 1.25 moving into still air at a pressure of 100 kPa and a temperature of 15°C. Find the velocity, pressure, temperature of the air behind the shock wave	Apply
12	Air flow at Mach 4 and pressure of 105 N/m2 is turned abruptly by a wall into the flow with a turning angle of 20°C as shown in the figure. If the shock is reflected by another wall determine the flow properties M and p downstream of the reflected shock.	Apply

		
13	A supersonic flow is expanded through a second convex turn of angle 10° as shown in the figure. Determine the downstream Mach number, pressure, temperature and the angle of second fan 	Apply
14	Derive θ-β-M relationship for oblique shock and define the strong and weak solutions	Understanding
15	A uniform supersonic air stream with upstream Mach number of 3, static pressure and static temperature of 1 atm and 300 K respectively encounters a compression corner which deflects the stream by an angle of 15°, calculate downstream static pressure and temperature, total pressure and temperature and Mach number	Apply
16	Consider the intersection of two shocks of opposite families as sketched in the figure for M1 = 3, P1 = 1 atm, θ2 = 20° and θ3 = 15°. Calculate the Mach number and pressure in region 4 and 4'. And also find the flow direction behind the refracted shocks 	Apply
17	A normal shock moves in a constant area tube as shown in figure. In region 1, V1 = 100 m/s, T1 = 300C and P1 = 0.7 atm. Shock speed CS with respect to a fixed coordinate system is 600 m/s. Find fluid properties in region 2	Apply
18	A shock wave across which the pressure ratio is 1.52 moving into still air at a pressure of 150 kPa and a temperature of 25°C. Find the velocity, pressure, temperature of the air behind the shock wave	Apply
	Unit 3	
1	With a neat sketch, illustrate Prandtl Meyer expansion round a convex corner	Understanding
2	Define Mach Reflection and regular reflection?	Remembering
3	Can we use the method of characteristics to determine the contour of a	Remembering

	supersonic nozzle? How	
4	Differentiate like reflection and unlike reflection	Remembering
5	Define characteristic lines and limiting characteristics	Remembering
6	What are right running and left running waves in supersonic flow?	Remembering
7	Show the heating and cooling processes in a Fanno curve for subsonic and supersonicflow	Remembering
8	Find out the length of the pipe for fanno flow, if the Mach number changes from 2.8at the entry to 1.0 at the exit. Take the friction factor for the pipe surface to be 0.0025?	Understanding
9	Bring out two important differences between Rayleigh Flow and Fanno Flow?	Remembering
10	Distinguish between mach lines and compression waves?	Remembering
	Part B	
11	Air at Mach 2 passes over two compression corners of angles 7° and θ as shown in the figure. Determine the value of θ up to which the second shock will remain attached 	Apply
12	For the double wedge shown in the figure, calculate the flow Mach numbers at 2, 2’, 3,3’ and 4 using shock expansion theory 	Apply
13	Consider an infinity thin flat plate at 5° angle of attack in a Mach 2.6 freestream. Calculate the lift and drag coefficients using shock expansion theory	Apply
14	For the flow over half – diamond wedge shown in the figure, find the inclinations of shock and expansion wave and the pressure distribution 	Apply
15	Explain the design procedure of Convergent – Divergent nozzle using the Method of Characteristics	Understanding
16	Derive and explain Prandtl-Meyer function of the expansion wave	Understanding
17	Air flows through a constant area duct whose walls are kept at a low temperature. The air enters the pipe at a Mach number of 0.52, a pressure of 200 kPa, and a temperature of 350°C. The rate of heat transfer from the air to the walls of pipe is estimated to be 400kJ/kg of	Apply

	air. Find the Mach number, temperature and pressure at the exit pipe.Assume that the flow is steady, that the effects of wall friction are negligible and that the air behaves as a perfect gas	
18	Air flows of a pipe with diameter 0.3m at a rate of 1000m3 per minute at a pressure and temperature of 150 kPa and 293 K respectively. If the pipe is 50m long, find the exit Mach number, pressure and temperature at the inlet. Assuming f = 0.005	Apply
19	Write short notes on (i) Supersonic flow over a wedge (ii) Weak Oblique shocks (iii) Supersonic Compression (iv) Supersonic Expansion by Turning	Understanding
20	Consider an infinity thin flat plate at 7° angle of attack in a Mach 2.8 freestream. Calculate the lift and drag coefficients using shock expansion theory	Apply
	Unit-4 Part A	
1	What do you mean by affine transformation	Remembering
2	Sketch the different types of supersonic profiles	Remembering
3	What are the assumptions of small perturbation potential theory?	Remembering
4	Give the compressibility correction given by Karman-Tsien and Laitone?Karman-Tsien compressibility correction	Remembering
5	What are subsonic and supersonic leading edges? Explain with sketches	Remembering
6	State Prandtl-Glauert rule	Remembering
7	Define critical Mach number of an airfoil? What are the types of critical Machnumber	Understanding
8	Explain the phenomena of lift divergence and drag divergence	Remembering
9	Why is there a sudden drag rise in transonic flow	Understanding
10	Explain the “coke bottle fuselage design” given by whitcomb?	Remembering
	Part B	
11	Based on small perturbation theory, derive the general linearized velocity potential equation for compressible flows	Understanding
12	Derive and describe Prandtl-Glauret affine transformation for subsonic flow over airfoils and highlight its significance	Understanding
13	Derive an expression for velocity potential equation and state the assumptions made	Understanding
14	Derive expression for linearized pressure coefficient equation	Understanding
15	Derive an expression for CL and CD of a symmetrical diamond profile in supersonic flow at small angle of attack	Understanding
16	A thin wing can be modelled as a 1m wide flat plate set an angle of 3° to the upstream flow, if this wing is placed in a flow with a Mach number of 3 and static pressure of 50 kPa, find using linearized theory the pressure on the upper and lower surface of the airfoil and lift and drag per meter span	Apply

17	A 2D wing profile shown in the figure, is place in a stream of Mach number 2.5at an incidence of 2°. Using linearized theory, calculate CL and CD 	Apply
18	Using linearized theory, calculate the lift and drag coefficients for a flat plate at a 7° angle of attack in a Mach 2.5 flow	Apply
19	A thin wing can be modelled as a 1m wide flat plate set an angle of 5° to the upstream flow, if this wing is placed in a flow with a Mach number of 2.5 and static pressure of 75 kPa, find using linearized theory the pressure on the upper and lower surface of the airfoil and lift and drag per meter span	Apply
	Unit 5 Part A	
1	Why is a converging diverging passage required to go from subsonic to supersonicflow	Remembering
2	Define characteristic Mach number and what is the maximum value of it?	Remembering
3	Define hodograph and pressure turning angle	Remembering
4	Define shock polar? Sketch the shape of shock polar for $\square_1^* = 2.45$	Understanding
5	What is meant by mach reflection	Remembering
6	What is meant by expansion hodograph	Remembering
7	An unsymmetrical diamond airfoil at zero angle of attack is kept in supersonic flow.Sketch the wave pattern and the streamlines	Understanding
8	By linearised theory, what are the expressions for the lift and drag coefficients for asymmetric bi convex profile?	Remembering
9	What is the effect of sweep back on compressibility	Remembering
10	Why is that airfoil designed for a high critical mach number must have a thin profile	Remembering
	Part B	
11	What is mean by transonic area rule? With neat sketch, explain in detail on transonic area rule	Understanding
12	What is mean by swept back wing? With neat sketches explain in detail about characteristics, advantages disadvantages of the effect of sweep back wing at supersonic and subsonic speeds	Understanding
13	With neat sketches explain in detail about upper and lower Critical Mach number	Understanding
14	Explain in detail about the effect of thickness, camber and aspect ratio on characteristics on wings	Understanding
15	Explain in detail about drag divergence Mach numbers	Understanding
16	With neat sketches, explain in detail about the shock induced separation	Understanding
17	Explain in detail about the reflection and interaction of the shock waves	Understanding