INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**HIGH SPEED AERODYNAMICS**				
Course Code	AAE008				
Programme	B.Tech				
Semester	V	AE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	--	--
Chief Coordinator	Mr. G Satya Dileep, Assistant Professor				
Course Faculty	Ms. D Anitha, Assistant Professor Mr. G Satya Dileep, Assistant Professor				

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 threedimensional 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	Understand the importance of quasi one dimensional flow for obtaining supersonic speeds.
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.

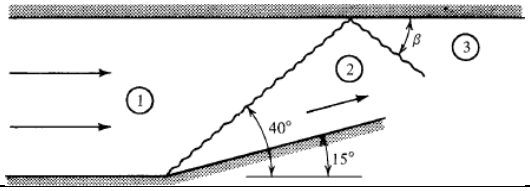
COURSE LEARNING OUTCOMES (CLOs):

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.

TUTORIAL QUESTION BANK

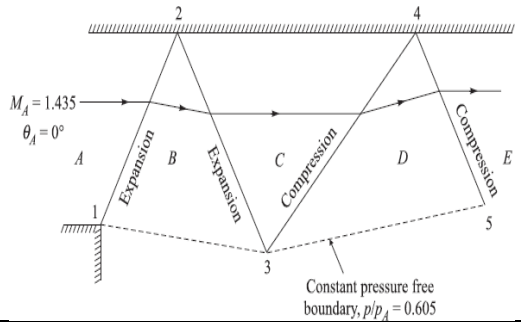
UNIT – I				
INTRODUCTION TO COMPRESSIBLE FLOWS				
Part - A(Short Answer Questions)				
S.NO	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes**
1	Define gas dynamics for compressible flows.	Remember	CO 1	AAE008.01
2	What is the difference between fluid mechanics and gas dynamics?	Remember	CO 1	AAE008.01
3	Define compressibility with respect to relevant properties of fluids.	Remember	CO 1	AAE008.01
4	What are the thermodynamics properties used in compressible flow?	Remember	CO 1	AAE008.02
5	What do you understand by specific heat?	Remember	CO 1	AAE008.02
6	What is bulk elasticity?	Remember	CO 1	AAE008.02
7	What do you understand by enthalpy?	Remember	CO 1	AAE008.02
8	Write short notes on ratio of specific heat.	Understand	CO 1	AAE008.02
9	What do you understand by Entropy?	Understand	CO 1	AAE008.02
10	Write the assumptions made for deriving momentum equation.	Remember	CO 1	AAE008.03
11	Define Mach number.	Remember	CO 1	AAE008.03
12	What do you understand by thermally perfect gas?	Understand	CO 1	AAE008.02
13	What do you understand by calorically perfect gas?	Understand	CO 1	AAE008.02
Part - B (Long Answer Questions)				
1	Derive the equations for the conservations of mass in integral form with the help of neat sketch.	Understand	CO 1	AAE008.03
2	With the help of neat sketch derive the equations for the conservations of momentum in integral form.	Understand	CO 1	AAE008.03
3	Derive the equations for the conservations of energy in integral form with the help of neat sketch.	Understand	CO 1	AAE008.03
4	Derive the pressure, density and temperature ratio along a streamline in isentropic flowwith suitable diagram.	Remember	CO 1	AAE008.02
5	With the help of neat sketch derive continuity equation in differential form for compressible flows with the help of neat sketch.	Remember	CO 1	AAE008.03
6	Derive momentum equation in differential form for compressible flows with the help of neat sketch.	Remember	CO 1	AAE008.03
7	Briefly explain entropy and Derive the entropy equations for perfect gas with the help of neat sketch.	Understand	CO 1	AAE008.02
8	Write short note on first law of thermodynamics and derive the energy equation in differential form.	Understand	CO 1	AAE008.02
9	What do you understand by supersonic flow and write down its relation with speed of sound?	Understand	CO 1	AAE008.03
10	What do you understand by sound speed .Derive the equation for sound speed in a perfect gas in the form$a = \sqrt{\gamma RT}$	Understand	CO 1	AAE008.02
Part - C (Analytical Questions)				
1	An aircraft is flying at a speed of 1000 kmph. Compute the variations in speed of sound a, and Mach number M with altitudechange from sea level and at 11 Km.	Understand	CO 1	AAE008.01
2	During a flight, a fighter aircraft attains its cruise speed of 600 m/s at 10 Km altitude after taking off at 150 m/s from sea level. Assuming the speed to have increased linearly withaltitude during the climb. Compute the variation in Mach number with altitude.	Understand	CO 1	AAE008.01
3	A fighter aircraft attains its maximum speed of 2160 kmph at an altitude of 12 Km. The take-off speed at sea level is 270 kmph. If the flight speed increases linearly with altitude, compute the variations in stagnation temperature with altitude for a climbing up to the maximum speed in steps of 3 Km.	Remember	CO 1	AAE008.03
4	Consider the flow properties at the point in the flow where the temperature is	Remember	CO 1	AAE008.02

	320 k and velocity is 100m/s. Calculate the Mach number at this point?			
5	At a point in the flow the pressure, temperature and velocity are 1atm, 320 k, and 1000m/s. Calculate the total temperature and total pressure at this point.	Understand	CO 1	AAE008.02
6	Calculate the ratio of kinetic energy to internal energy at a point in the flow where the Mach number is M=2 and M=20.	Remember	CO 1	AAE008.03
7	For a point in the flow where temperature is 320k and velocity is 100m/s calculate the Mach number.	Understand	CO 1	AAE008.03
8	Consider airplane flying at an altitude of 20,000m. The pressureat a point on the wing is 19152N/m^2, assuming isentropic flow over the wing, calculate the temperature at this point?	Remember	CO 1	AAE008.02
9	Consider a rectangular floor that is 5m by 7m and a 5m height ceiling, The air pressure and temperature in the room are 1atm and 25c respectively, calculate the internal energy and enthalpy of the air in the room.	Remember	CO 1	AAE008.02
10	Consider a rectangular room that is 5m by 10m and a 5m height ceiling, The temperature and air pressure in the room is 350c and 3atm respectively, calculate the enthalpy and internal energy of the air in the room.	Understand	CO 1	AAE008.02
UNIT II				
SHOCK AND EXPANSION WAVES				
Part – A (Short Answer Questions)				
1	Write short note on development of shock wave.	Remember	CO 2	AAE008.04
2	What do you understand by shock wave?	Remember	CO 2	AAE008.04
3	What are the different types of shock waves?	Remember	CO 2	AAE008.04
4	Define supersonic flow.	Understand	CO 2	AAE008.04
5	Write the properties of normal shock?	Understand	CO 2	AAE008.04
6	Mach number downstream of normal shock is always subsonic. Justify?	Understand	CO 2	AAE008.04
7	Define characteristic Mach number.	Understand	CO 2	AAE008.04
8	Flow through normal shock is adiabatic. Justify?	Understand	CO 2	AAE008.05
9	What do you understand by expansion fans?	Understand	CO 2	AAE008.04
10	What is the maximum turning angle for ideal gas?	Remember	CO 2	AAE008.05
11	Why temperature increases behind the shock wave?	Remember	CO 2	AAE008.04
12	Why temperature decreases behind the expansion fans?	Remember	CO 2	AAE008.05
13	What is the difference between normal shock and oblique shock?	Remember	CO 2	AAE008.04
14	What is reflected shock?	Understand	CO 2	AAE008.04
15	What is Rayleigh-Pitot correction?	Understand	CO 2	AAE008.04
Part - B (Long Answer Questions)				
1	Briefly explain the normal shock and Derive Prandtl Relation for normal shock in perfect gas?	Remember	CO 2	AAE008.04
2	Why the Mach number is always subsonic behind the normal shock? Justify your Answer.	Remember	CO 2	AAE008.04
3	Derive the relation for normal shock for a perfect gas in terms of M_1 and M_2briefly.	Understand	CO 2	AAE008.04
4	Derive the expression for density relationship for normal shock for a perfect gas in terms of Mach number.	Remember	CO 2	AAE008.05
5	Derive the expression for pressure relationship for normal shock for a perfect gas in terms of Mach number.	Remember	CO 2	AAE008.05
6	What do you understand by perfect gas? Derive the equation for speed of shock in perfect gas.	Understand	CO 2	AAE008.04
7	Explain the theta-Beta-Mach relation for wide range of supersonic flowwith suitable diagram.	Remember	CO 2	AAE008.04
8	With the help of neat sketch briefly explain the Rayleigh-Pitot correction? Why it is done?	Remember	CO 2	AAE008.04
9	Write short notes on shockwave and boundary layer interaction and explain them.	Understand	CO 2	AAE008.06

10	Define total pressure. Derive the expression for total pressure change across a normal shock.	Understand	CO 2	AAE008.06
	Part - C (Analytical Questions)			
1	A normal shock wave is formed in air where upstream Mach number is 2 and upstream temperature, pressure and density are 300K. 1 atm (i.e. 1 atmospheric pressure, which is approximately1.01 x 10^5 N/m^2) and 1.2 kg/m^3 respectively. Calculate Mach number, velocity, static temperaturestatic pressure, stagnation temperature and stagnation pressuredown- stream of the shock. Assume γ=1.4.	Remember	CO 2	AAE008.04
2	Calculate the lift and drag coefficients for a flat plate at5^0angle of attack in a Mach 3 flow.	Remember	CO 2	AAE008.04
3	A Mach 2 air stream passes over a 10^0 expansion corner. Findthe Mach number of the flow downstream of the expansion fan. Which expansion corner will produce Mach number 2.5?	Remember	CO 2	AAE008.04
4	A normal shock wave occurs in a nozzle in which air is steadily flowing. Because the shock has a very small thickness, changes in flow variables across the shock may be assumed to occur without change of cross-sectional area. The velocity just upstream of the shock is 500 m/s, the static pressure is 50 kPa and the static temperature is 250 K. On the downstream side of theshockthepressureis137kPaandthetemperatureis343.3K. Determine the velocity of the air just downstream of the shock.	Understand	CO 2	AAE008.05
5	Air flow at Mach 4.0 pressure 105 $N/m^2$is turn abruptly by a wall into the flow with a turning angle of 15 degree as shown in fig below. If the shock is reflected by anotherwall determine the flow properties M and p downstream of the reflected shock. 	Understand	CO 2	AAE008.05
6	A supersonic flow at Mach number =2, temperature=300K, pressure 1 atm, and density=1.2 kg/m3 approaches a compressible corner. An attached oblique shock with wave angle=45 degree is found at the corner. Find the normal Mach numbers upstream and downstream of the shock. Also, find M2,p2, p02, Assume γ =1.4.	Remember	CO 2	AAE008.05
7	A supersonic flow with M_1 = 1.5 , p_1= 1 atm and T_1= 288k is expanded around a sharp corner through a deflection angle 15^0.calculate T_2,V_2,and the angles that the forward and rearward Mach lines with respect to the upstreamflow direction .	Remember	CO 2	AAE008.05
8	Consider an infinitesimally thin flat plate at an angle of attackin a Mach 2.3 flow. Calculate the lift and wave drag co- efficient for an angle of attack $\alpha=5^0$.	Understand	CO 2	AAE008.06
9	For a flow with M=2, P=1atm and T=288k, this flow is deflected at a compression corner through 20^0. calculate M,P,T.	Remember	CO 2	AAE008.05
10	A supersonic flow with M_1 = 1.5 , p_1= 1 atm and T_1= 288K is expanded around a sharp corner through a deflection angle 15^0. Calculate T_2,V_2,and the angles that the forward and rearward Mach lines with respect to the upstreamflow direction .	Understand	CO 2	AAE008.05
	UNIT –III			
	ONE DIMENSIONAL AND QUASI ONE DIMENSINAL FLOW			
	Part – A (Short Answer Questions)			
1	What is a chocked flow?	Understand	CO 3	AAE008.08
2	Write about over-expanded flow at the nozzle exit?	Understand	CO 3	AAE008.08
3	How does the position of the normal shock vary with the back pressure at the exit of the nozzle?	Remember	CO 3	AAE008.08

4	What is back pressure?	Remember	CO 3	AAE008.08
5	Write an equation for area velocity relation.	Remember	CO 3	AAE008.08
6	Write about under-expanded flow at the nozzle exit.	Remember	CO 3	AAE008.08
7	Define quasi one dimensional flow.	Understand	CO 3	AAE008.07
8	Write minimum conditions to be satisfied for flow through nozzle to chock.	Understand	CO 3	AAE008.08
9	What is the reason for formation of oblique shock at the nozzle exit for over-expanded condition?	Understand	CO 3	AAE008.08
10	What is the reason for formation of expansion fan at the nozzle exit for under-expanded condition?	Understand	CO 3	AAE008.08
11	Write area Mach number relation.	Understand	CO 3	AAE008.08
12	Define fanno flow and write its application.	Understand	CO 3	AAE008.09
13	Define Rayleigh flow and write its application.	Understand	CO 3	AAE008.09
14	What is the effect of friction in downstream flow properties if inlet Mach number is subsonic?	Remember	CO 3	AAE008.09
15	What is the effect of friction in downstream flow properties if inlet Mach number is supersonic?	Remember	CO 3	AAE008.09
16	What happens to flow properties if heat is added to subsonic flow?	Understand	CO 3	AAE008.09
17	What happens to flow properties if heat is added to supersonic flow?	Remember	CO 3	AAE008.09
	Part – B (Long Answer Questions)			
1	What do you understand by area velocity relation and obtain an expression for area velocity relation?	Remember	CO 3	AAE008.08
2	Describe the isentropic flow in nozzles. Explain about wave reflection from free boundary?	Remember	CO 3	AAE008.08
3	Give a brief outline of operation of supersonic wind tunnels employing convergent -divergent nozzles?	Remember	CO 3	AAE008.07
4	Explain about choked flow, ideally expanded, over-expanded, under expanded flows in detail.	Remember	CO 3	AAE008.08
5	Write about appearance of normal shock in nozzle flow with the help of neat sketch?	Understand	CO 3	AAE008.08
1	What is mass flow rate, give the effect of stagnation conditions, back pressure?	Remember	CO 3	AAE008.08
2	Define the terms area ratio and Mach number and derive the relation between area ratio and Mach number.	Remember	CO 3	AAE008.08
3	Define friction coefficient and Derive the equation for effect of friction on fluid properties.	Remember	CO 3	AAE008.09
4	Explain about variation of flow properties when heat is added to subsonic and supersonic flow	Understand	CO 3	AAE008.09
5	Write short notes on Fanno flow and Rayleigh flow with the reference conditions.	Remember	CO 3	AAE008.09
	Part - C (Analytical Questions)			
1	At a given point on the surface of an airfoil, the pressure coefficient is -0.3 at very low speeds. If the free stream Mach number is 0.6, calculate C_p at this point.	Remember	CO 3	AAE008.08
2	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.	Understand	CO 3	AAE008.07
3	$P_0$is 50atm, T_0 is 5200K, A^* is 0.8m^2, R is 220J/KgK, Calculate the mass flow rate.	Remember	CO 3	AAE008.08
4	Calculate the mass flow through the nozzle assuming that reservoirs temperature is 288K and throat area is 0.3 m^2.	Understand	CO 3	AAE008.07
5	A pitot tube at the exit of a supersonic nozzle reads, 8.92X 10^4 N/m^2. If the	Remember	CO 3	AAE008.08

	reservoir pressure is 2.02 X 10^5 N/m^2, calculate the area ratio of the nozzle (Ae/A^*).			
1	The reservoir pressure and temperature for a convergent divergent nozzle are 5atm and 288.8K, The flow is expanded isentropically at the nozzle exit, if the exit to throat area ratio is 2.983, calculate the following properties. a) Machnumber b) Temperature at theexit c) Density at theexit d) Pressure at theexit	Remember	CO 3	AAE008.08
2	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 1.448atm, what is the reservoir pressure for the tunnel.	Remember	CO 3	AAE008.08
3	For a design of a Mach 2 supersonic wind tunnel, calculate the ratio of diffuser throat area to the nozzle throat area.	Remember	CO 3	AAE008.08
4	Calculate the mass flow rate using the close form analytical expression where $P_0$is 30atm, T_0 is 3500K, A^* is 0.4m^2, R is 520J/KgK.	Understand	CO 3	AAE008.09
5	Consider the isentropic supersonic flow with a convergent divergent nozzle with an exit through throat area ratio of 10.25, the reservoir pressure and temperature are 5atm and 333.33 K. Calculate M, P and T.	Understand	CO 3	AAE008.09
	UNIT -IV			
	APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES			
	Part – A (Short Answer Questions)			
1	What do you understand by supersonic area rule?	Remember	CO 4	AAE008.11
2	Write the compatibility relation between v and θ	Remember	CO 4	AAE008.11
3	What is critical Mach number?	Remember	CO 4	AAE008.11
4	What is divergence Mach number?	Remember	CO 4	AAE008.11
5	Write short notes on super critical airfoil.	Remember	CO 4	AAE008.11
6	What is ideally expanded flow?	Remember	CO 4	AAE008.11
7	What are all the general features we observe for properties of Mach lines and expansion flow?	Understand	CO 4	AAE008.11
8	Draw the critical Mach number of symmetrical aerofoil.	Remember	CO 4	AAE008.11
9	Why preheating of air is required for a hypersonic wind tunnel?	Remember	CO 4	AAE008.11
10	What is sonic boom?	Understand	CO 4	AAE008.11
	Part – B (Long Answer Questions)			
1	Derive the small perturbation equation for subsonic, transonic and supersonic flow.	Remember	CO 4	AAE008.10
2	Write short notes on “Elements of the Method of Characteristics”. High light the internal points and wall points.	Remember	CO 4	AAE008.12
3	Write Short notes on “elements of finite-difference methods”. High light the physical planes and computational planes.	Remember	CO 4	AAE008.12
4	Derive the equation for determining characteristic lines for two dimensional irrotational flow.	Remember	CO 4	AAE008.12
5	Derive compatibility equation for two dimensional irotational flows with the neat sketch.	Remember	CO 4	AAE008.12
6	Briefly explain about critical Mach number, Drag Divergence and Mach number with its relations.	Understand	CO 4	AAE008.11
7	Describe the super-critical airfoils with the neat sketch and list the applications of super-critical airfoils.	Remember	CO 4	AAE008.12
8	Explain about whitcombs transonic area rule.	Remember	CO 4	AAE008.11
9	Briefly explain the sound barrier and swept wings at transonic speed.	Understand	CO 4	AAE008.11
10	Define Method of characteristics. Explain the supersonic nozzle design using method of characteristics.	Remember	CO 4	AAE008.12

Part - C (Analytical Questions)				
1	Solve the flow field at the exit of an under expanded two- dimensional nozzle with air flow shown in figure. At the nozzle exit, M_A=1.435 and θ_A=0^0 	Remember	CO 4	AAE008.11
2	At a given point on the surface of the aerofoil, the pressure coefficient is -0.3 at very low speed. If the freestream Mach number is 0.6, calculate C_p at thispoint.	Understand	CO 4	AAE008.11
3	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 thispoint.	Remember	CO 4	AAE008.11
4	For certain aerofoil at given point on the upper surface of the aerofoil, the pressure coefficient is -0.3 at very low speed. If the free stream Mach number is 0.8, calculate $C_p$and C_m at thispoint.	Remember	CO 4	AAE008.11
5	List out the different methods employed to postpone the critical Mach number.	Understand	CO 4	AAE008.11
6	Calculate theoretical lift co-efficient for above airfoil is in an incompressible flow is $c_l=2.\pi.a$ for $M\infty=0.8$.	Remember	CO 4	AAE008.11
7	The theoretical lift co-efficient for a thin symmetrical airfoil is in an incompressible flow is cl = 2.π.a. Calculate the lift coefficient for M∞ =0.7.	Understand	CO 4	AAE008.11
8	Calculate the pressure at the top and bottom surfaces of the flat plate using linearized theory?	Remember	CO 4	AAE008.10
9	Calculate L/D ratio for flight conditions of Mach 2.0 at an altitude of 11km. for these conditions the wing angle of attack is 0.035rad, assume chord length of airfoil is 2.2m.	Remember	CO 4	AAE008.11
10	Explain method of characteristics for the application to supersonic nozzle design?	Understand	CO 4	AAE008.12
UNIT – V				
EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS				
Part - A (Short Answer Questions)				
1	Classify the wind tunnel.	Remember	CO 5	AAE008.13
2	Why do you need wind tunnels?	Remember	CO 5	AAE008.13
3	What are the different industrial applications for wind tunnels?	Remember	CO 5	AAE008.13
4	What are the different types of shock tunnels?	Remember	CO 5	AAE008.14
5	What are the different measuring techniques used in wind tunnel?	Remember	CO 5	AAE008.13
6	Which techniques are used for flow visualization in supersonicflow?	Remember	CO 5	AAE008.15
7	What is the working principle of Schlieren technique?	Understand	CO 5	AAE008.15
8	What is the source of errors during supersonic wind tunnel test?	Understand	CO 5	AAE008.13
9	Why second throat is required for supersonic wind tunnel?	Understand	CO 5	AAE008.14
10	Why monochromatic light is used for flow visualization?	Understand	CO 5	AAE008.15
Part - B (Long Answer Questions)				
1	Give a brief outline of operation of supersonic wind tunnels employing convergent -divergent nozzles?	Understand	CO 5	AAE008.13
2	Write short note on supersonic wind tunnel and its parts with the suitable diagram.	Understand	CO 5	AAE008.13

3	What do you understand by shock tunnel? Explain different types of shock tunnel with suitable diagram?	Remember	CO 5	AAE008.14
4	What do you understand by expansion tube? Explain with the suitable diagram.	Remember	CO 5	AAE008.14
5	Define flow visualization. List the different types of flow visualizations available for compressible flow?	Understand	CO 5	AAE008.15
6	Write the working principle of Schlieren techniques with the suitable diagram.	Remember	CO 5	AAE008.15
7	Write the working principle of Shadow-graph techniques with suitable diagram?	Remember	CO 5	AAE008.15
8	Briefly explain the Impulse-Type Tunnels and Free Piston shock Tunnel with the neat sketch.	Understand	CO 5	AAE008.15
9	Write about supersonic wind tunnel operation and fluid properties along the flow direction.	Remember	CO 5	AAE008.14
	Part - C (Analytical Questions)			
1	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.	Remember	CO 5	AAE008.13
2	A Subsonic open-circuit wind tunnel runs with a test section speed of 40 m/s. The temperature of the lab environment is 16^0 C. If the turbulent sphere measures the turbulent factor TF (defined as the ratio of theoretical critical Reynolds number for the sphere to the actual critical Reynolds number) of the tunnel as 1.2, determine the sphere diameter. Assume the test section pressure as the standard sea-level pressure.	Understand	CO 5	AAE008.13
3	A closed return type wind tunnel of large contraction ratio has air at standard sea level conditions in the settling chamber upstream of the contraction to the test-section. Assuming isentropic compressible flow in the tunnel, estimate the speed and the kinetic energy per unit area in the working section when the Mach number is 0.75.	Remember	CO 5	AAE008.13
4	Explain the Effect of second throat in a Supersonic Tunnel, with suitable diagram.	Understand	CO 5	AAE008.14
5	Determine the minimum possible diffuser contraction ratio and the power required for a two stage compressor to run a closed circuit supersonic tunnel at M=2.2. The efficiency of the compressor is 85%, p_{oi} = 4 atm, To = 330K, and ATS = 0.04m^2. Assume P_{o2}/P_{o1}=0.6281 and area ratio A1/A*= 1.005.	Remember	CO 5	AAE008.13
6	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?	Remember	CO 5	AAE008.13
7	Explain the dynamic similarity between a wind tunnel model and the prototype to be flight-tested. 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?	Understand	CO 5	AAE008.13
8	List industrial domain where wind and fluid tunnels are used. Explain its applications in their respective domain.	Remember	CO 5	AAE008.13
9	List the different types of supersonic wind tunnel? Explain applications of each wind tunnels in different fields	Understand	CO 5	AAE008.13

Prepared by:

Mr. G Satya Dileep, Assistant Professor

HOD, AE