INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**AERODYNAMICS II**
Course Code	:	**A52107**
Class	:	III B. Tech I Semester
Branch	:	AERO
Year	:	2017 – 2018
Course Coordinator	:	Mr. N V Raghavendra, Associate Professor
Course Faculty	:	Mr. N V Raghavendra, Associate Professor

OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S No	Question	Blooms Taxonomy level	Course Outcomes
UNIT - I THERMODYNAMICS IN FLUID MOTION			
Part - A (Short Answer Questions)			
1	**Explain** about compressible and incompressible flow.	Understand	1
2	**Explain** types of thermodynamic equilibrium in brief.	Understand	1
3	**State** First law of Thermodynamics.	Knowledge	1
4	**What** is internal energy for a gas? Explain.	Knowledge	1
5	**Explain** throttling process.	Knowledge	1
6	**Explain** adiabatic, isentropic processes.	Understand	1
7	**Write** entropy change relations.	Remember	1
8	**Give** isentropic relations for a flow.	Understand	1
9	**Explain** types of thermodynamic system.	Understand	1
10	**Describe** a reversible process.	Understand	1
Part - B (Long Answer Questions)			
1	**Define** compressibility of flow. Give the expression for compressibility?	Understand	1

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2	**Write** short notes on internal energy, enthalpy, calorifically perfect gas and perfect gas?	Understand	1
3	**Explain** about adiabatic, reversible, irreversible and isentropic processes?	Understand	1
4	**Explain** Joule Thompson experiment and throttling process?	Analyze	1
5	**What** is a system? Explain all types of thermodynamic systems?	Understand	1
6	**When** is a system said to be in equilibrium? Explain different types of equilibrium?	Understand	1
7	**Explain** Mach number? How are flows classified based on Mach numbers?	Remember	1
8	**What** are variables of state? Explain first law of thermodynamics. Write equation for first law reversible process?	Understand	1
9	**What** is isentropic process? Derive isentropic relations?	Remember	1
10	**Explain** second law of thermodynamics? Write equations for entropy change relations?	Understand	1
Part - C (Problem Solving and Critical Thinking Questions)			
1	Consider the flow properties at the point in the flow where the temperature is 320 k and velocity is 100m/s. Calculate the Mach number at this point?	Evaluate	2
2	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.	Evaluate	2
3	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.	Evaluate	2
4	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.	Evaluate	2
5	Consider airplane flying at an altitude of 20,000m. The pressure at a point on the wing is 19152N/m2, assuming isentropic flow over the wing, calculate the temperature at this point?	Evaluate	2
6	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.	Analyze	2
7	At a point in an airflow the pressure, temperature and velocity are 1atm, 320k and 1000m/s. Calculate the total temperature and pressure at this point.	Analyze	2
8	For a point in the flow where temperature is 320k and velocity is 100m/s calculate the Mach number.	Evaluate	2
9	Calculate the ratio of stagnation temperate to static temperature at a point in the flow where the Mach number is M=5.	Analyze	2
10	At a point in the flow the pressure, temperature and velocity are 5atm, 150 k, and 100m/s. Calculate the total temperature and total pressure at this point.	Analyze	2
UNIT - II ONE DIMENSIONAL FLOWS			
Part – A (Short Answer Questions)			
1	**Write** continuity equation for a 1-D flow.	Understand	3

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2	**Write** the continuity and momentum equation for constant area duct.	Understand	3
3	**Write** 1-D momentum equation for inviscid flow?	Understand	3
4	**Write** the relations across a normal shock?	Remember	3
5	**What** is Mach number state its significance?	Understand	3
6	**Write** the equation for measurement of air speed in compressible subsonic flow.	Remember	3
7	**Write** the equation for measurement of air speed in compressible supersonic flow.	Remember	3
8	**Write** the energy equation?	Remember	3
9	**Explain** throttling process?	Understand	3
10	**Write** equation for relations between stagnation pressures, density with Mach number.	Remember	3
	Part - B (Long Answer Questions)		
1	**Obtain** an equation for continuity? Write continuity equation for 1-D flow?	Understand	3
2	**Obtain** an equation for momentum for in viscid flow and write its equation in 1-D?	Understand	3
3	**Derive** continuity and momentum equation for constant area duct?	Understand	3
4	**Obtain** relation for area and velocity for a flow over a nozzle?	Remember	3
5	**Obtain** the relations for normal shock?	Understand	3
6	**Obtain** normal shock wave basic equations?	Remember	3
7	**Derive** an equation for relation between stagnation pressure /density and Mach number?	Remember	3
8	**Explain** entropy rise across normal shock and its relation to pressure rise?	Remember	3
9	**Explain** about the measurement of air speed in compressible subsonic and supersonic flows?	Understand	3
10	**Discuss** various forms of energy equation.	Understand	3
	Part – C (Problem Solving And Critical Thinking)		
1	At a point in an airflow the pressure, temperature and velocity are 1atm, 320k , and 1000m/s. Calculate the total temperature and total pressure at this point?	Evaluate	4
2	The temperature and pressure at the stagnation point of a high - speed missile is 518.9k and 7.8atm respectively. Calculate the density at the point.	Evaluate	4
3	The temperature and pressure at the stagnation point of a high - speed missile is 518.9k and 7.8atm respectively. Calculate the density at the point. Calculate Cp, Cv, e and h for air at standard sea level conditions.	Analyze	4
4	Consider a normal shock wave in air where the upstream flow properties are 680m/s, T1 =288k, and P1= 1 atm. calculate the velocity , temperature and pressure downstream the shock.	Analyze	4

S No	Question	Blooms Taxonomy level	Course Outcomes
5	Consider a body of arbitrary shape if the pressure distribution over the surface of the body is constant, prove that the resultant pressure force on the body is zero.	Evaluate	4
6	Consider air at a temperature of 230K, calculate the speed of sound.	Evaluate	4
7	The temperature in the reservoir of a supersonic wind tunnel is, 288K, in the test section, the flow velocity is 422.15 m/s. calculate the test section mach number, assume the tunnel flow is adiabatic.	Evaluate	4
8	Consider the isentropic flow through a supersonic nozzle if the test section conditions are given by P is 1atm, T is 230K, Mach is 2 calculate the reservoir pressure and temperature.	Evaluate	4
9	Consider a flow with pressure and temperature of 1 atm and 288K, a pitot tube is inserted in to the flow and measures a pressure of 1.55 atm, what is the velocity of the flow.	Analyze	4
10	At a given point in the flow, T is 300K P is 1.2 atm, V is 250m/s, calculate the corresponding values of P_0, T_0, M^*, P*.	Evaluate	4
UNIT-III OBLIQUE SHOCK AND EXPANSION WAVES			
Part - A (Short Answer Questions)			
1	**Difference** between oblique and normal shocks?	Remember	6
2	**Write** short notes on supersonic flow over the wedge?	Understand	6
3	**What** is a Mach wave?	Understand	6
4	**Write** short notes on wave drag?	Understand	6
5	**Write** short notes on supersonic flow over a diamond airfoil?	Understand	6
6	**Explain** Mach reflection and slip stream?	Understand	6
7	**Write** short notes on detached shock wave in front of a bluff 2-D body?	Understand	6
8	**What** is shock standoff distance?	Understand	6
9	**Differentiate** between weak oblique shock and strong oblique shock?	Understand	6
10	**Write** about intersection of shocks?	Understand	6
Part – B (Long Answer Questions)			
1	**Write** notes on supersonic flow over a wedge and cone with attached shock?	Remember	6
2	**What** is a Mach wave, Mach line, Mach angle?	Understand	6
3	**Write** about shock boundary layer interactions?	Understand	6
4	**Explain** supersonic flow over a flat plate at an angle of attack?	Understand	6
5	**Write** about intersection of shocks, Mach reflection?	Understand	6
6	**Explain** shock detachment and analyze the flow for large wedge angles?	Analyze	6
7	**Explain** about detached shock wave in front of a bluff 2-D body?	Analyze	6
8	**Write** about expansion fan and Prandtl-Meyer function?	Understand	6
9	**What** is shock expansion theory how it is applicable to supersonic airfoils?	Analyze	6

S No	Question	Blooms Taxonomy level	Course Outcomes
10	**Analyze** Supersonic flow over a diamond airfoil?	Understand	6
	Part – C (Problem Solving and Critical Thinking)		
1	A wedge with a 15^0 half angle in a Mach 5 flow, calculate drag co - efficient?	Evaluate	6
2	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 upstream flow direction .	Evaluate	6
3	Calculate the lift and drag coefficients for a flat plate at 5^0 angle of attack in a Mach 3 flow.	Evaluate	6
4	A slender missile is flying at Mach 1.5 at low altitude. Assume the wave generated by the nose of the missile is a Mach wave. This wave intersects the ground 559ft behind nose .at what altitude is the missile flying?	Evaluate	6
5	Consider the flow over a 22.2^0 half angle wedge .If M_1=2.5 P_1= 1atm and T_1= 300k, calculate the wave angle and p_2 T_2.	Evaluate	6
6	For pressure 1atm, Mach 3 calculate the total pressure behind the shock.	Analyze	6
7	Consider an infinitesimally thin flat plate at an angle of attack in a Mach 2.3 flow. Calculate the lift and wave drag co-efficient for an angle of attack $\alpha=5^0$.	Analyze	6
8	A supersonic flow at M_1=1.58 and p_1 = 1atm expands around a sharp corner .If the pressure downstream of the corner is 0.1306atm; calculate the deflection angle of the corner.	Evaluate	6
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.	Analyze	6
10	A wedge with a 45^0 half angle in a Mach 5 flow, calculate lift co-efficient?	Evaluate	6
	UNIT-IV **MORE ONE DIMENSIONAL FLOWS AND SUBSONIC AND TRANSONIC AIRFOILS**		
	Part – A (Short Answer Questions)		
1	**What** is a choked flow?	Understand	7
2	**Write** about over expanded flow at the nozzle exit?	Understand	7
3	**How** does the position of the normal shock vary with the back pressure at the exit of the nozzle?	Understand	7
4	**What** is back pressure?	Understand	7
5	**Write** an equation for area velocity relation?	Understand	7
6	**What** do you mean by steady level flight?	Remember	7
7	**What** is critical Mach number?	Understand	7
8	**What** is divergence Mach number?	Remember	7
9	**Write** short notes on super critical aerofoil?	Understand	7

S No	Question	Blooms Taxonomy level	Course Outcomes
10	**What** is ideally expanded flow?	Remember	7
	Part – B (Long Answer Questions)		
1	**Obtain** an expression for area velocity relation?	Understand	7
2	**Explain** about wave reflection from free boundary?	Understand	7
3	**Give** a brief outline of operation of supersonic wind tunnels employing convergent -divergent nozzles?	Understand	7
4	**Explain** about choked flow, ideally expanded, over-expanded, under expanded flows?	Understand	7
5	**Write** about appearance of normal shock?	Understand	7
6	**What** is mass flow rate, give the effect of stagnation conditions, back pressure?	Remember	7
7	**Explain** about critical Mach number, Drag Divergence Mach number?	Understand	7
8	**Write** about super-critical airfoils?	Remember	7
9	**Explain** about whitcombs transonic area rule?	Understand	7
10	**Write** about sound barrier, swept wings at transonic speed?	Analyze	7
	Part – C (Problem Solving And Critical Thinking)		
1	At a given point on the surface of an aerofoil, 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.	Evaluate	8
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.	Evaluate	8
3	P_0 is 50atm, $T_{0\ is}$ 5200K, A^* is 0.8m^2, R is 220J/KgK, calculate the mass flow rate.	Evaluate	8
4	Calculate the mass flow through the nozzle assuming that reservoirs temperature is 288K and throat area is 0.3 m^2	Evaluate	8
5	A pitot tube at the exit of a supersonic nozzle reads, 8.92X 10^4 N/m^2. If the reservoir pressure is 2.02 X 10^5 N/m^2, calculate the area ratio of the nozzle (Ae/A^*).	Evaluate	8
6	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) Mach number b) Temperature at the exit c) Density at the exit d) Pressure at the exit	Evaluate	8
7	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.	Evaluate	8

S No	Question	Blooms Taxonomy level	Course Outcomes
8	For a design of a Mach 2 supersonic wind tunnel, calculate the ratio of diffuser throat area to the nozzle throat area.	Evaluate	8
9	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.	Evaluate	8
10	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.	Evaluate	8
	UNIT-V **AIRFOIL, WING AND CONE IN SUPERSONIC FLOW**		
	Part - A (Short Answer Questions)		
1	**Explain** the principle of limited upstream influence in supersonic flow?	Understand	9
2	**When** is a flow said to be hypersonic? Give examples?	Remember	9
3	**Write** short notes on wind ward surface and Lee ward surface?	Understand	9
4	**Write** short notes for Delta wing with supersonic leading edge?	Understand	9
5	**Write** short notes for Delta wing with subsonic leading edge?	Understand	9
6	**What** are the qualitative aspects of hypersonic flow?	Understand	9
7	**Write** the ordinary Differential equation for a conical flow?	Understand	9
8	**What** is a semi -infinite cone	Remember	9
9	**Compare** pressure rise for wedge and cone of equal semi-angle?	Understand	9
10	**What** is the difference between the flow over the wedge and cone?	Remember	9
	Part - B (Long Answer Questions)		
1	**Explain** about method of characteristics?	Understand	9
2	**Write** about air loads over flat rectangular wings of finite span?	Understand	9
3	**Explain** about windward and leeward surface	Apply	9
4	**Give** ordinary differential equation for conical flow?	Remember	9
5	**Explain** comparison of pressure rise for wedge and cone of equal semi-angle?	Remember	9
6	**Derive** expression for lift and drag of flat plate wings at hypersonic speeds	Understand	9
7	**Write** the governing equations for linearized supersonic flow?	Remember	9
8	**Explain** principle of limited upstream influence in supersonic flow?	Understand	9
9	**Explain** the flow phenomena for a delta wing with supersonic leading edge and subsonic leading edge?	Understand	9
10	**Explain** method of characteristics for the application to supersonic nozzle design?	Understand	9
	Part – C (Problem Solving and Critical Thinking)		
1	Consider a flat plat at angle of attack 20^0 in Mach 20 free stream. Using straight Newtonian theory, calculate the lift – and wave drag coefficients.	Evaluate	9

S No	Question	Blooms Taxonomy level	Course Outcomes
2	Using linear zed theory, calculate the lift and drag co-efficient for a flat at 5^0 angle of attack in a Mach 3 flow.	Evaluate	9
3	Calculate the lift and wave drag coefficients for an infinitely thin flat plate in a Mach 2.6 free stream at angles of attack of 5^0.	Evaluate	9
4	Consider diamond wedge airfoil with a half –angle $\varepsilon = 10^0$. The airfoil is at angle of attack 15 to a Mach 3 free stream.	Evaluate	9
5	The theoretical lift co-efficient for a thin, symmetric airfoil in an incompressible flow is $c_l = 2\pi\alpha$. Calculate the lift coefficient for M free stream =0.7.	Analyse	9
6	At a given point on the surface of an airfoil, the pressure co-efficient is -0.3 at very low speeds. If free stream Mach number is 0.6 calculate Cp at this point.	Evaluate	9
7	Consider a flat plat at angle of attack 50^0 in Mach 20 free stream. Using straight Newtonian theory, calculate and co-efficient of lift.	Analyse	9
8	Consider diamond wedge airfoil with a half –angle $\varepsilon = 10^0$. The airfoil is at angle of attack 15 to a Mach 5 free stream. Calculate lift.	Analyse	9
9	Calculate the pressure at the top and bottom surfaces of the flat plate using linearized theory?	Evaluate	9
10	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.	Analyse	9

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