INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	AEROSPACE PROPULSION II
Course Code	:	A62112
Class	:	III B. Tech II Semester
Branch	:	AERONAUTICAL ENGINEERING
Year	:	2017 – 2018
Course Coordinator	:	C.Satya Sandeep –Assistant Professor
Course Faculty	:	Dr.M.Pandiyan – Professor, C.Satya Sandeep – Assistant 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 TRANS-ATMOSPHERIC AND SPACE FLIGHT MISSION PROPULSION REQUIREMENTS			
Part - A (Short Answer Questions)			
1	What are the various types of mission profiles of a space craft?	Remember	1
2	Explain the term orbital injection.	Understand	1
3	Quote different space launch vehicle types?	Understand	1
4	What are military missiles?	Understand	3
5	Explain specific impulse and its importance in propulsion.	Understand	2
6	Write a short note on the term specific thrust	Remember	1
7	Define propulsive efficiency	Remember	2
8	What is meant by internal efficiency	Remember	2
9	List out the applications of reaction control systems	Remember	2
10	Differentiate between rocket propulsion and jet propulsion?	Remember	2
Part - B (Long Answer Questions)			
1	Derive an expression for Breguet equation for cruise	Remember	1

2	Explain the types of High speed propulsion systems , its construction, and operating principles	Remember	1
3	Write a short note on incremental flight velocity, budget for climb out and acceleration	Understand	2
4	List out the propellants and power generation in hypersonic speed vehicles	Remember	2
5	Explain about Reaction control systems and its applications	Understand	2
6	What is the difference between the propulsion of low speed aircraft by propellers and that of high speed aircraft and missiles by jet propulsion engines?	Remember	2
7	Describe the main advantage in using ramjet? What is the major limitation of the ramjet? Also briefly discuss the limitations on the lowest and the highest flight Mach numbers in a subsonic combustion ramjet.	Remember	1
8	Define all the six orbital elements and explain their importance in creating an orbit.	Remember	1
9	Explain with neat sketch the anomaly of orbital coordinate system with all the elements	Understand	2
10	List out the sources of energy in hypersonic environmental applications and detail each one of them.	Remember	2
Part - C (Problem Solving and Critical Thinking Questions)			
1	How does scramjet-powered hypersonic vehicles work? Write about the shock formations and there effects on the engine.	Remember	2
2	Quantify the main characteristics of space flight and detail its applications in real-time scenario.	Understand	2
3	We are getting closer to revolutionizing transcontinental military and commercial aeronautics? Detail the development aspects which lead to this development.	Understand	2
4	What are the conditions of idealization under which process in an air breathing propulsion system can be considered as these of joule or Brayton cycle?	Understand	2
5	A rocket burns fuel at a rate of 1.2 kg/s, with an exhaust velocity of 1250 m/s. what thrust does it develop.	Remember	2
6	What is the total Δ V required for launching a vehicle from earth surface and have to reach a LEO at 100Km, assume initial radius to be 6400 km & final radius 6500 Km.	Understand	2
7	What are the typical propulsion requirements of ΔV for different mission profiles?	Understand	2
8	How does scramjet-powered hypersonic vehicles work? What are the main design considerations and limitations of it?	Remember	2
9	A rocket engine uses the same propellant, mixture ratio, and combustion chamber pressure as that in problem 1.5. If the propellant flow rate is 500 kg/s, Calculate the area of the exhaust nozzle throat.	Understand	2
10	The rocket engine in problem the above problem is optimized to operate at an elevation of 2000 Meters. Calculate the area of the nozzle exit and the section ratio.	Remember	2

UNIT - II **AIRBREATING ENGINES FOR HYPERSSONIC TRANSPORT PLANES AND MILITARY MISSILES**			
Part – A (Short Answer Questions)			
1	Is it possible to use subsonic combustion chamber for hypersonic flight? Justify.	Remember	4
2	Mention advantages and disadvantages of ramjet engine.	Remember	3
3	How is a ramjet different from turbojet?	Understand	3
4	List out the possible applications of ramjet?	Remember	3
5	Explain the need for supersonic combustion?	Understand	3
6	List out the applications of integral ram-rocket propulsion system?	Remember	3
7	What are the methods of thrust augmentation?	Understand	3
8	Explain the types of thrust vector controls?	Remember	3
10	What are the different types of supersonic intakes?	Understand	
Part - B (Long Answer Questions)			
1	Determine the maximum velocity of a rocket and the altitude attained from the following data: Mass ratio =0.15 Burn out time =75s Effective jet velocity =2500m/s	Understand	3
2	What are the values of the velocity and altitude losses due to gravity? Ignore drag and assume vertical trajectory	Remember	4
3	With a neat sketches the principle of operation of ram jet engine		4
4	Explain the construction and operation of a ramjet engine and derive an expression for the ideal efficiency	Understand	4
5	A missile has a maximum flight speed to jet speed ratio of 0.2105 and specific impulse equal to 203.88 seconds. Determine for a burn out time of 8 seconds a) Effective jet velocity b) Mass ratio and propellant mass functions c) Maximum flight speed, and c)Effective jet velocity d) Altitude gain during powered and coasting flights	Understand	3
6	With the help of a neat sketch describe the working of a ramjet engine. Depict the various thermodynamic process occurring in it on h-s diagram. What is the effect of flight Mach number on its efficiency?	Remember	3
7	The orbital and escape velocities of a rocket at mean sea level and an altitude of 300km from the following	Remember	4
8	Calculate data Radius of earth at mean sea level =6341.6Km Acceleration due to gravity at mean sea level =9.809 m/s^2	Remember	4
9	Explain what are the reasons and specifications of spill over drag, plume drag. Discuss any possible ways to reduce them.	Remember	4
10	Sketch and explain the working of the air turbo-rocket (ATR). Write down its applications and advantages.	Understand	3
Part – C (Problem Solving and Critical Thinking)			
1	Discuss on the main reasons which lead to the limitations of a ramjet engines.	Understand	4
2	Explain with a neat sketch the working of a turbo-pump feed system used in a liquid propellant rocket?	Remember	4

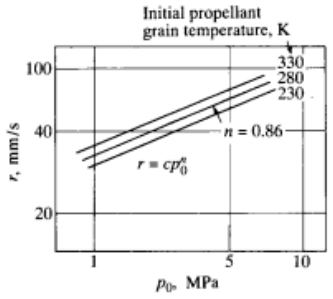
3	With a neat sketches the principle of operation of: 1.turbo fan engine and 2.ram jet engine	Remember	4
4	A spacecraft's engine ejects mass at a rate of 30 kg/s with an exhaust velocity of 3,100 m/s. The pressure at the nozzle exit is 5 kPa and the exit area is 0.7 m2. What is the thrust of the engine in a vacuum?	Understand	4
5	A 5,000 kg spacecraft is in Earth orbit traveling at a velocity of 7,790 m/s. Its engine is burned to accelerate it to a velocity of 12,000 m/s placing it on an escape trajectory. The engine expels mass at a rate of 10 kg/s and an effective velocity of 3,000 m/s. Calculate the duration of the burn.	Understand	4
6	With a neat sketch the working of a turbo-pump feed system used in a liquid propellant rocket?	Understand	4
7	Derive a mathematical expression of the Impulse & Momentum	Remember	4
8	A rocket engine uses the same propellant, mixture ratio, and combustion chamber pressure as that in problem 1.5. If the propellant flow rate is 500 kg/s, calculate the area of the exhaust nozzle throat.	Evaluate	
9	For the rocket engine in problem 1.7, calculate the volume and dimensions of a possible combustion chamber. The convergent cone half-angle is 20 degrees.	Remember	3
10	A two-stage rocket has the following masses: 1st-stage propellant mass 120,000 kg, 1st-stage dry mass 9,000 kg, 2nd-stage propellant mass 30,000 kg, 2nd-stage dry mass 3,000 kg, and payload mass 3,000 kg. The specific impulses of the 1st and 2nd stages are 260 s and 320 s respectively. Calculate the rocket's total V.	Understand	4
UNIT-III CHEMICAL ROCKET ENGINES			
Part - A (Short Answer Questions)			
1	Differentiate between 1-d and 2-d flows.	Remember	5
2	Write a short note on the history on chemical rocket propulsion.	Understand	5
3	Explain the different types of the chemical rockets.	Remember	4
4	Explain the terms of rocket equation.	Remember	4
5	Write a short note on the Vehicle velocity and the jet exit velocity	Understand	4
6	List out the various types of rocket propellants.	Remember	4
7	Sketch and explain the thrust chamber- processes.	Remember	5
8	List out the design parameters of a nozzle.	Understand	4
9	What is meant by two phase flow	Understand	4
10	Write a short note on frozen equilibrium	Remember	5
11	Write a short note on motor case conditions	Remember	6
12	Explain the Nozzle Expansion Processes in a rocket motor	Understand	5
13	Quote the importance of the Computer Analysis in chemical propulsion	Remember	7
14	What are the fuels used for hypersonic propulsion	Remember	8
15	Explain the chemical combustion process	Understand	5
16	Explain the nozzle expansion process	Remember	4

17	Explain the physical or chemical reasons for a maximum value of specific impulse at a particular mixture ratio of oxidizer to fuel.	Remember	5
18	Explain the effect of atmosphere on propulsion	Understand	6
19	Explain about the combustion efficiency	Understand	5
20	What is meant by mass ratio	Remember	4
21	Explain the main terms of the rocket equation	Remember	4
22	Derive tsiloskys equation for delta V	Understand	5
23	Explain what are the trade-offs of delta V	Remember	6
24	Explain how delta plays a key role in spacecraft transfers	Understand	4
1	Explain about equilibrium composition.	Remember	5
2	Explain what is meant by the recombination.	Understand	5
3	Write a short note on nozzle expansion.	Remember	4
4	What are the factors effecting the performance of engine.	Remember	4
5	Explain the design parameters used in manufacturing a nozzle	Understand	4
6	Write a short note on analysis of non-equilibrium expansion	Remember	4
7	Write down the equations involved during the expansion of the nozzle	Remember	5
8	What is the significance of the throat diameter of a nozzle	Understand	4
9	Write down important combustion equations	Understand	4
10	Explain about the shifting equilibrium	Remember	5
11	How computing of rocket engine performance is implemented	Remember	6
12	What is meant by the delivered performance	Understand	5
13	What is meant by performance at standard operating conditions	Remember	7
14	What is meant by guaranteed minimum performance	Remember	8
15	Explain about the losses in combustion chamber	Understand	5
16	Explain about the propulsive efficiency	Remember	4
17	What is meant exhaust velocity	Remember	5
18	What is meant by effective velocity	Remember	5
19	What is meant by thrust coefficient	Understand	5
20	Define specific impulse and what are the factors effecting specific impulse	Remember	4
21	What are the properties of a chemical rocket	Remember	4
22	Explain what is meant by frozen equilibrium	Understand	4
23	Write a short note on temperatures generated in combustion chamber	Remember	4
24	Explain about the presence of liquid drops and solid particles in chemical combustion.	Remember	5
Part – B (Long Answer Questions)			
1	Derive a mathematic expression for the combustion efficiency. List out the significance of the same.	Understand	5
2	Explain how the performance measurement of a chemical rocket engine is implemented.	Remember	5
3	Write about the temperatures developed in the thrust chamber and equations related to it.	Remember	6

4	Differentiate between characteristic velocities, exhaust velocity, effective velocity.	Understand	6
5	How the Thermo- chemical analysis of combustion chamber does is performed. What is the importance of it?	Understand	6
6	Explain about the Equilibrium composition of chemical propellants in detail with the chemical compositions of them.	Understand	6
7	Discuss how the altitude and the atmospheric conditions effect the engine starting procedures and performances	Remember	6
8	Describe the importance of combustion chamber design with its elements of design parameters.	Understand	6
9	Write a short note on the Equilibrium composition and recombination in chemical rocket propulsion.	Understand	6
10	Differentiate between theoretical, delivered performance, performance at standard operating conditions and guaranteed minimum performance	Understand	6
11	Write a short note on • Effect of atmosphere • Engine parameters • Propellants used in chemical rockets.	Understand	6
12	Describe what can be the effect of the presence of liquid drops and solid particles.	Understand	6
13	Differentiate between equilibrium energy balance and mass balance. Write a short note on their importance.	Understand	6
14	In detail derive the computation of the performance of the rocket engine. Write down important expressions involved.	Remember	5
15	Discuss theoretical and delivered performance of chemical rockets with neat sketches	Understand	7
16	How the presence of liquid drops and solid particles does effects the rocket engine performance .Explain in detail.	Remember	5
	Part – C (Problem Solving and Critical Thinking)		
1	A spacecraft's dry mass is 75,000 kg and the effective exhaust gas velocity Of its main engine is 3,100 m/s. How much propellant must be carried if the Propulsion system is to produce a total v of 700 m/s?	Understand	6
2	A spacecraft launched from Earth has a burnout velocity of 11,500 m/s at an Altitude of 200 km. What is the hyperbolic excess velocity?	Remember	7
3	A rocket engine uses the same propellant, mixture ratio, and combustion chamber pressure as that in problem 1.5. If the propellant flow rate is 500 kg/s, Calculate the area of the exhaust nozzle throat. For the rocket engine in problem calculate the volume and dimensions of a possible combustion chamber. The convergent cone half-angle is 20 degrees.	Remember	6
4	Calculate the radius of orbit for a Earth satellite in a geosynchronous orbit, Where the Earth's rotational period is 86,164.1 seconds.	Understand	5
5	How the optimizing Expansion is for Maximum Thrust is achieved. Sketch and explain under expansion over expansion nozzles.	Understand	5

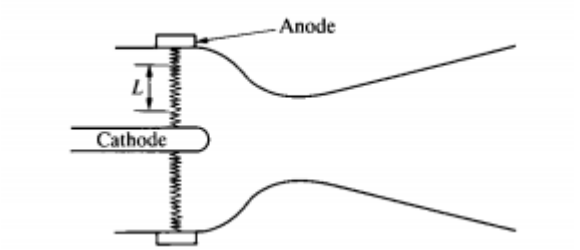
6	What is meant by the Adiabatic Flame Temperature? Write down the balanced chemical equations involved in it.	Understand	6
7	Write a short note on Cryogenic Reactants and explain their significance in combustion of a chemical rocket.	Remember	5
8	What are the different types of Engine Cooling techniques? Explain each one of them with their importance.	Understand	6
9	Explain the significance of the Product Generation Rate. Where is it applicable in practical scenario?	Remember	5
10	What is meant by the Monopropellant Engines? Write the practical applications of the same.	Remember	5
UNIT-IV LIQUID PROPELLANT ROCKET ENGINES, SOLID PROPELLANT ROCKET MOTORS			
Part – A (Short Answer Questions)			
1	List out some of the liquid rocket propellant fuels.	Remember	7
2	Write a short note on cooling in liquid rocket motor.	Remember	7
3	Sketch and explain the basic parts of a liquid rocket motor.	Remember	7
4	List out the important parts of a solid rocket motor	Remember	7
5	List out some of the solid rocket propellant fuels.	Understand	7
6	Explain the configuration of an hybrid propellant	Remember	7
7	List out the examples of solid propellant boosters	Understand	7
8	Discuss the parameters used in the selection of rocket propulsion systems	Remember	7
9	Explain the fundamental physical limitations of thermal rockets	Understand	8
10	Brief the particular of upcoming propulsion systems for space travel	Understand	7
Part – B (Long Answer Questions)			
1	Explain with suitable sketches the need and methods for cooling of rockets engine thrust chamber.	Remember	7
2	Write short note on a. Gas pressure feed system b. Turbo pump feed system	Understand	8
3	Discuss about oxidizers and fuels of liquid propellant rocks. Also state what is monopropellant and bipropellant?	Remember	7
4	What are the common problems associated with liquid propellants and what are the desired properties of liquid propellants.	Understand	8
5	Explain a. Charge design b. thrust profile c. burning stability d. erosive burning	Remember	9
6	List out the essential differences from liquid propellant rocket engines. Discuss on which one is best for space travel.	Understand	9
7	Write a short note on a. ignition surface recession rate b. gas generation rate c. effect of propellant temperature	Understand	10

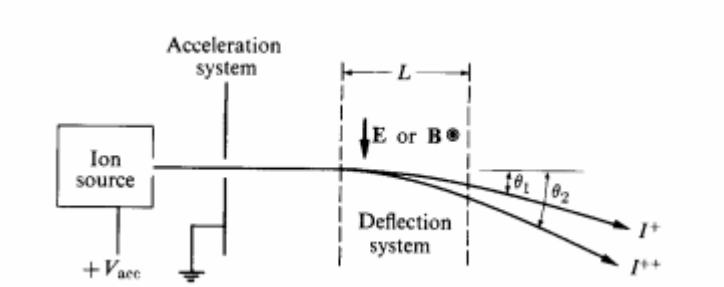
8	What is water testing of liquid rocket injectors? How is it done? What is its application	Remember	7
9	Explain different types of combustion instabilities and the corrective measure to minimise the effect.	Remember	8
10	Sketch and explain the working principles of the pulse detonation engine and the rotary rocket engine	Understand	9
Part – C (Problem Solving and Critical Thinking)			
1	A solid rocket motor burns along the face of a central cylindrical channel 10 meters long and 1 meter in diameter. The propellant has a burn rate coefficient of 5.5, a pressure exponent of 0.4, and a density of 1.70 g/ml. Calculate the burn rate and the product generation rate when the chamber pressure is 5.0 MPa.	Remember	9
2	Calculate the ideal density of a solid rocket propellant consisting of 68% Ammonium perchlorate, 18% aluminium, and 14% HTPB by mass.	Remember	10
3	The grain in a solid propellant rocket is a hollow cylinder bonded to the casing so that it burns only on its inner cylindrical surface and on one end. Its density is 1650 kg/m3, and its burning rate is characterized by r = 13.3 (P0 MPa) 0 63 mm/s. At a point in the burning period when p0 = 0.7 MPa, the grain d/D = 0.4 and L/D = 6, L being the grain length and d and D being its Inner and outer diameters. Determine the rate of change of chamber pressure, Assuming the gas temperature stays constant at 2750 K and that the gas specific heat ratio is y = 1.24. D = 1 m.	Understand	10
4	The burning rate of a particular propellant is given by r = c/(7) - T) p$ in which r is in mm/s, p0 is in MPa, T is in K and c = 176 Ti = 415 K n = 0.716 When the propellant initial temperature is 20°C, the chamber pressure is 3 MPa (steady) for 4 min. If the same propellant grain in the same rocket is heated to 45°C, what would be the new steady state pressure level and Burning period. Assume the time required to reach steady state is small compared to the burning time.	Remember	9

5	A certain solid propellant burns at a rate shown in the figure. It is being used In a rocket combustion chamber in which the stagnation pressure is approximately constant at 3.5 MPa. The initial grain temperature is 280 K. Suddenly a large crack develops in the propellant grain, which increases the burning area by 10%. What will happen to the chamber pressure? If the gas temperature, chamber volume, burning area, and throat area were known, show how the pressure transient could be calculated.  	Understand	10
6	A rocket is to be designed to produce 5 MN of thrust at sea level. The pressure in the combustion chamber is 7 MPa and the temperature is 2800 K. If the working fluid is assumed to be a perfect gas with the properties of air at room temperature, determine the following: (a) specific impulse, (b) mass Flow rate, (c) throat diameter, (d) Exit diameter. For the same nozzle find (e) thrust at 30-kM altitude; (f) thrust at sea level if chamber pressure were increased to 21 MPa; (g) thrust with hydrogen at the same inlet stagnation conditions; and (h) thrust with stagnation temperature increased to 3600 K.	Understand	9
7	Using a propellant of molecular weight 15 and flame temperature 3300 K, the rocket throat and exhaust areas required for a thrust of 500 kN ideal specific impulse of 300 sec. The ambient pressure is 0.1 MPa, and the specific-heat ratio of the propellant is 1.4. How much thrust would this rocket develop if the ambient pressure were changed to 0.03 MPa? How much thrust would be developed by a rocket designed to expand to 0.03 MPa if it had the same stagnation conditions, throat area	Understand	10
8	Rocket thrust chamber has been designed for a chamber pressure P0 of 2.0 MPa and “correct” expansion at 10-km altitude where the ambient pressure is 26.5 kPa. The chamber has to be tested at sea level with the design value of the chamber pressure but with back pressure nearly four times the Design value. Is it likely that a shock wave will enter the nozzle under test conditions? At what back pressure could a plane normal shock stand in the end plane of the nozzle? Let y = 1.4.	Understand	10

9	A chemical rocket is used for launch into earth orbit. At the end of the combustion chamber the stagnation temperature is 3000 K. The molecular weight of the combustion products is 26. The gases expand isentropic ally as an ideal gas mixture with specific-heat ratio 1.2. The area ratio AJA* of the nozzle is 20, and the throat diameter is 0.1 m. Determine, a. The stagnation pressure if the expansion is correct at sea level; b. The rocket thrust at sea level, 15-km, 30-km, and 60-km altitude.	Understand	9
10	An experimental rocket thrust chamber has an outside wall temperature of 400 K at the throat, with a 3200-K chamber temperature. The local heat transfer rate is measured to be 15 MW/m2, of which 25% may be assumed due To radiation. If the wall is of stainless steel 2.5 mm thick with k = 26 W/m K, and if the coolant surface area is the same as the hot-gas surface area, (a) What is the inner wall temperature? (b) It is expected that this temperature will cause failure in the actual application. The throat is to be lined with a ceramic of conductivity k = 8 W/m • K to protect the metal. Assuming that the fraction of heat transfer by radiation is unchanged and that all gas properties are unchanged, what ceramic thickness is necessary to reduce the peak metal temperature to 1370 K while the coolant side remains at 400 K? The heat flux is steady and the effects of the wall curvature and axial heat conduction can be considered negligible.	Understand	10
UNIT-V ELECTRICAL THRUSTERS			
Part - A (Short Answer Questions)			
1	How the performance estimation of electrical thrusters does is done.	Understand	11
2	Explain where the Electric Thrusters are used.	Remember	11
3	With neat sketch explain the principle of a resisto jet	Remember	11
4	What are the functions of the accelerator grids?	Remember	11
5	Explain the working principle of an arc jet	Remember	11
6	What is meant by ionization potential	Understand	11
7	How solar/laser/microwave engines help in space travel.	Remember	11
8	Define electrical efficiency	Remember	11
9	List out the applications of thrust per unit area	Understand	12
10	Write a short note on exhaust neutralization	Remember	11
Part - B (Long Answer Questions)			
1	Differentiate between magneto plasma dynamic (MPD), pulsed plasma (PPT) with neat sketches.	Understand	11
2	Explain Hall Effect. List of the practical application of hall effect in electric propulsion.	Understand	12
3	Write a short note on the Electric space power supplies and power conditioning with their advantages and limitations.	Understand	12
4	List out the Particulars of selection current electric propulsion systems.	Remember	11

5	Explain the functions of a) Fuel cells b) Solar cell arrays c) Solar generators d) Nuclear power generators.	Remember	13
6	Describe the working principle of ionic thruster with neat sketch explaining each part and its functions.	Create	11
7	Describe the operating principles, components, system parameters, performance, and applications of the thermal propulsion.	Understand	11
8	Explain the operating principles, components, system parameters, performance, and applications of the nuclear propulsion.	Understand	12
9	List out the specifications of some of the real time space vehicles which use electric propulsion.	Understand	12
10	Explain the limitations of the nuclear propulsion. Also explain the advantages and applications of the same.	Remember	11
	Part – C (Problem Solving and Critical Thinking)		
1	Water vapour with specific heat ratio 1.3 expands in a small resist jet nozzle From initial conditions 1000 K and 10 MPa. The overall pressure ratio is 300. Frictional and heat transfer effects are negligible in the converging part of the nozzle, but in the remainder the polytrophic index is 1.2, and the exit stagnation temperature is 728 K. Estimate the specific impulse, the required area ratio, and the mass flow rate for a thrust of 1 N with operation in a vacuum.	Evaluate	13
2	Nitrogen is heated in an arc jet from 300 to 7350 K at 1 atm and dissociates almost entirely to atomic nitrogen. One-third of the electrical power supplied is lost to the arc chamber walls. The heated N then expands in a nozzle of area ratio $A/A^* = 100$ to vacuum. Assuming frozen flow and negligible effects of friction and heat transfer, estimate the specific impulse and the thrust-to-power ratio. Take $y = 5/3$.	Understand	13
3	A resisto jet has a throat diameter of 0.3 mm and is to be operated with helium at a pressure of 6.89 MPa (1000 psi). The exhaust nozzle exit diameter is 3.0 mm. The specific heat may be taken as y = 1.67. The maximum temperature is 1000 K.	Understand	14
4	If the loss in an ion thruster may be written as e, = (100 + 0.1AK) eV, determine: a. The efficiency; b. The thrust-to-power ratio for the xenon ion thruster operating at 7sp values of 1000, 2000, 3000, 4000, and 5000	Understand	12

5	In the arc jet illustrated in the diagram, arc length L is 1 cm and the voltage Across it is 100 V. The voltage drop across the anode layer, which is $A_{,,}$ = 1 mm thick, is 22 V. The voltage difference across the cathode layer, Which is Ac = 3 mm, is 37 V. Assuming half the electrical heating energy of the cathode layer goes into the cathode and that all of the heating energy of the anode layer goes into the anode, estimate the fractional loss to the walls of the energy added To the flow and the total power input. The arc current is 25,000 A. he working fluid is helium, which enters the arc jet at 2.1 MPa and 300 K. Its flow rate is 44.64 g/s, and the polytrophic expansion coefficient is estimated to be 1.37. The nozzle area ratio is 20:1. Determine the specific impulse of the arc jet, assuming as a first approximation that nozzle heat transfer is negligible and that friction is important only downstream of the nozzle throat 	Understand	12
6	Using an accel-decel system with 0.2-mm spacing between electrode plates, +1400 V on the screen electrode, and — 500 V on the accelerator electrode, determine the space-charge-limited values of the following for Cs, Hg, and Xe ions: a. Current density, mA/cm2; b. thrust density, N/cm2.	Remember	13

7	Two positive ions of the same mass, one singly charged and the other doubly charged, are accelerated from zero velocity through the same potential, Vacc, after which they travel through a deflection region of length L. Calculate the ratio 62/61, where 02 refers to the doubly and the singly charged ion for the following cases: (a) deflection due to a uniform E field as shown; (b) Deflection due to a uniform B field as shown; (c) deflection due to both E a B fields as shown. The deflection angles may be assumed small. 	Understand	11
8	A caesium ion rocket is to be used at a specific impulse of 5000 s. Assuming the caesium to be 100% singly ionized (q/m = 7.25 X 105 C/kg), what is the Required acceleration voltage and the beam power {mu]/ 2) per unit thrust? If the caesium is 90% singly ionized and 10% doubly ionized, what is the Specific impulse and beam power per unit thrust, assuming that the acceleration voltage is unchanged?	Understand	12
9	An electrostatic rocket is to use heavy particles with charge-to-mass ratio of 500 C/kg to produce a specific impulse of 3000 s. What acceleration voltage Would be necessary? With one-dimensional space-charge-limited current and a maximum allowable gradient of 105 V/cm, what is the diameter of a round beam producing 0.5 N thrust?	Understand	12
10	A resist jet is to be designed to supply a specific impulse of 310 s and a total Thrust of 10 N. It is to be operated with ammonia in a nozzle with an area Ratio of 100:1. The specific-heat ratio during the expansion is 1.3, and the Expansion may be assumed (first approximation only) to be adiabatic. Determine the maximum temperature for two cases: a. No dissociation of the NH3, b. 50% dissociation of the NH3 (into N2 and H 2) in the heating chamber, followed by frozen expansion	Remember	11

Prepared By:

Dr.M.Pandiyan - Professor
C.Satya Sandeep – Assistant professor

HOD, AERO