



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	ROCKET AND MISSILES				
Course Code	AAE518				
Programme	B. Tech				
Semester	VIII	AE			
Course Type	Professional Elective - IV				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Chief Coordinator	Mr V. Phaninder Reddy, Assistant Professor				
Course Faculty	Mr V. Phaninder Reddy, Assistant Professor				

COURSE OBJECTIVES:

I	Learn Fundamentals of rocket and missile systems, functions and disciplines and the full spectrum of rocket systems, uses and technologies.
II	Understand the Fundamentals and uses of solid, liquid and hybrid rocket systems and differences between systems built as weapons and those built for commerce.
III	Explain the use of low and high fidelity performance modeling, including performance loss factors, Staging theory, performance and practices for multi-stage rockets.
IV	Discuss the reliability issues in rocket systems, and strategies to improve reliability, including random and systematic failures, non-linear reliability curves.

COURSE OUTCOMES (COs):

CO 1	Describe the Classification of launch vehicles and missiles and its dynamics
CO 2	Differentiating the components of and the design considerations of solid and hybrid rocket systems and some design problems
CO 3	Understanding the concept of liquid propulsion system ,component classification and design problems in rocket systems
CO 4	Estimation of optimization techniques od navigation and guidance system in rockets ,missiles and its aerodynamics control systems
CO 5	Acquiring knowledge on design, materials and testing of rocketsspace environment on the selection of materials for rockets and spacecraft

COURSE LEARNING OUTCOMES (CLOs)

S. No.	Description
AAE518.01	List out the classification of launch vehicles and missiles, rocket systems, airframe component
AAE518.02	Acquire the basic knowledge on forces and moments acting on a rocket, propulsion, aerodynamics, gravity of rocket missiles
AAE518.03	Examine the equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems
AAE518.04	Illustrate the solid propellant rockets and enlist components and their design considerations, propellant grain design
AAE518.05	Demonstrate the ballistics and burn rate design issues, igniter design, types of nozzles, thrust vector control, pyrotechnic devices and systems
AAE518.06	List out the classification, mechanisms and application of pyrotechnic devices in rockets and missiles; design problems in rocket systems
AAE518.07	Describing the Liquid propellant rockets, classification and components
AAE518.08	Understanding the concepts of thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications, design considerations
AAE518.09	Differentiate the bipropellant systems like cryogenics and their characteristics
AAE518.10	Interpret Navigation and guidance systems in rockets and missiles, aerodynamic control systems of missiles
AAE518.11	Categorize multi-staging of rockets, vehicle optimization techniques, stage separation system
AAE518.12	Identify the separation techniques which are used for rocket flight dispersion, numerical problems
AAE518.13	Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft
AAE518.14	Describe the material selection for specific requirements, advance materials, super alloys and composite materials
AAE518.15	Examine the qualification of rocket and missile systems, types of testing and evaluation of design and function

UNIT – I

Rocket Dynamics

PART - A (SHORT ANSWER QUESTIONS)

S. No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes (COs)	Course Learning Outcomes (CLOs)
1	Difference between Rocket and Missile.	Remember	CO1	AAE518:01
2	Classify missiles on the basis of its purpose	Remember	CO1	AAE518:04
3	Mention airframe components of rockets and missiles.	Understand	CO1	AAE518:02
4	Draw a neat sketch of electric rocket and explain briefly.	Remember	CO1	AAE518:05
5	Write a short note on different types of chemical rockets.	Understand	CO1	AAE518:03
6	State various advantages of Liquid Propellants over solid propellant rockets?	Understand	CO1	AAE518:05
7	What is the basic difference between rocket propulsion and jet propulsion? Can rockets work in vacuum	Understand	CO1	AAE518:05
8	What are various types of oxidizers in common use in rockets?	Remember	CO1	AAE518:06
9	Elucidate the term propulsive efficiency?	Understand	CO1	AAE518:06
10	Elucidate the terms specific thrust and specific Impulse equation of a Rocket.	Remember	CO1	AAE518:06

PART - B (LONG ANSWER QUESTIONS)

1	Illustrate briefly four major subsystems of rocket and explain three main key parameters for Rocket Engine design.	Remember	CO1	AAE518:04
2	Explain classes of Missiles with neat sketches?	Understand	CO1	AAE518:04
3	Elucidate briefly the functions of components of Missile?	Remember	CO1	AAE518:04
4	How rockets can be classified? What is the stage of development of each type.	Understand	CO1	AAE51805
5	Elucidate briefly different types of chemical rocket based on the propellant used?	Understand	CO1	AAE518:05
6	Illustrate briefly long range cruise trajectory with neat sketches.	Remember	CO1	AAE518:05
7	Illustrate Air to air missile with neat sketch.	Understand	CO1	AAE518:06
8	Elucidate various parallel and normal forces acting on Rocket/Missile?	Remember	CO1	AAE518:06
9	Differentiate ballistic missile from cruise missile. Give examples.	Understand	CO1	AAE518:06
10	Illustrate in detail various applications of Rocket propulsion. What is the difference between effective exhaust velocity and the equivalent velocity?	Remember	CO1	AAE518:06

PART – C (PROBLEM SOLVING AND CRITICAL THINKING)

1	Obtain an equation for the ideal velocity of rocket in terms of payload ratio, structural efficiency and specific impulse.	Remember	CO1	AAE518:04
2	A Rocket Projectile has following characteristics: Initial mass =300kg, Mass after rocket propulsion=200kg. Payload, Non propulsive structure etc= 110 kg. Rocket operation duration=3 sec, Average Isp of propellant=240 sec. Determine Vehicle mass ratio, Propellant mass fraction, flow rate Thrust and Thrust to Weight ratio.	Remember	CO2	AAE518:04
3	Derive a general expression for the thrust produced by a chemical rocket and hence discuss the importance of the molecular weight of the propellants	Understand	CO1	AAE518:04
4	Describe how nuclear energy can be used for propulsion of rockets. Has it been used so far?	Remember	CO1	AAE518:05
5	A solid propellant rocket motor at sea level has following measurements. Burn duration=40sec, Initial mass before test= 1210 kg, Mass of	Remember	CO1	AAE518:05

6	What factors are important in the comparison of propulsive devices? State the optimum operational range, specific fuel consumption and relative weights for various propulsion devices.	Understand	CO1	AAE518:05
7	Elucidate briefly various Rocket performance parameters with equations.	Remember	CO1	AAE518:05
8	A rocket motor burns propellant at rate of 50 kg/s. The exhaust speed is 3500 m/s and the nozzle is perfectly expanded, Calculate the I. Rocket Thrust in KN II. The Rocket motor specific Impulse	Understand	CO1	AAE518:06
9	Why is m-dot important to the astronaut phrase "Throttle up"? What does "Throttle up" mean.	Remember	CO1	AAE518:06
10	A rocket Engine has an I_{sp} of 363 sec and can produce a thrust of 2MN. Calculate the equivalent velocity m-dot of the engine. Determine the mass ratio required to reach a change in velocity of 7700m/s.	Understand	CO1	AAE518:06

UNIT - II

SOLID PROPULSION AND PYROTECHNICS

PART - A (SHORT ANSWER QUESTIONS)

S No	QUESTIONS	Blooms Taxonomy level	Course Outcomes (Cos)	Course Learning Outcomes (CLOs)
1	What is propellant burning rate?	Understand	CO2	AAE518.04
2	State double base propellant from a homogeneous propellant grains?	Remember	CO2	AAE518.05
3	State composite propellant from heterogeneous propellant grain?	Remember	CO2	AAE518.04
4	What are burning rate modifiers?	Understand	CO2	AAE518.05
5	Demonstrate the purpose of plasticizers in propellants?	Remember	CO2	AAE518.05
6	Define Smokeless or Low-Smoke Propellant	Understand	CO2	AAE518.06
7	What are the phases of ignition process?	Understand	CO2	AAE518.04
8	What are the requirements of igniter propellant?	Remember	CO2	AAE518.04
9	List any four propellant characteristics in rocket motor.	Remember	CO2	AAE518.04
10	Define web fraction and volumetric loading fraction.	Remember	CO2	AAE518.06

PART - B (LONG ANSWER QUESTIONS)

1	What are the principal components and features of solid propellant rocket motors?	Understand	CO2	AAE518.04
2	Name the applications of solid propellant rocket motors and explain in detail.	Remember	CO2	AAE518.05
3	How the propellant burning rate in a full scale solid rocket motor can be increased.	Remember	CO2	AAE518.05
4	Explain the methods of holding grain in rocket motor case.	Understand	CO2	AAE518.04
5	What are the failure modes of solid rocket motor?	Understand	CO2	AAE518.06
6	What are the load and failure modes in case bonded rocket?	Remember	CO2	AAE518.04
7	What are the basic types of igniters and explain any one of the igniter in detail with sketch.	Understand	CO2	AAE518.05
8	Explain the working principle of pyrotechnic igniters with simple sketch.	Understand	CO2	AAE518.06
9	List out the nozzles used for rocket motors and explain in details.	Remember	CO2	AAE518.05
10	What are the materials and their functions of rocket motor nozzle?	Understand	CO2	AAE518.05
11	Explain the terminology of grain configuration.	Knowledge	CO2	AAE518.06

PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)

1	What are propellant ingredients which are common propellant ingredient for double base propellants?	Understand	CO2	AAE518.04
2	Demonstrate the purpose of powdered spherical aluminum in solid fuels with few applications in aerospace techniques?	Remember	CO2	AAE518.04

3	Summarize igniter propellant which is the process of propellant ignition and also enlist several types of igniter hardware?	Remember	CO2	AAE518.05
4	Write simple relationship for the thickness at any location in the motor depends on the exposure time, the erosion rate (obtained from erosion tests at the likely gas velocity and temperature), and the safety factor.	Understand	CO2	AAE518.05
5	Why thrust vector control mechanism is used in rockets?	Understand	CO2	AAE518.04
6	Demonstrate the purpose of powdered spherical aluminum in solid fuels with few applications in aerospace techniques?	Remember	CO2	AAE518.05
7	Illustrate the amount of additives are used in accelerating or lengthening the curing time.	Understand	CO2	AAE518.04
8	Summarize the purpose of energetic binders which are used in the conventional organic materials.	Remember	CO2	AAE518.06
9	Explain Thrust Vector control mechanisms with neat sketches.	Understand	CO2	AAE518.04
10	Explain the principal of propellant processing and manufacturing of solid propellant involves complex physical and chemical processes.	Understand	CO2	AAE518.05
11	What are the requirements to design grain configuration?	Remember	CO2	AAE518.06
UNIT-III				
LIQUID AND HYBRID ROCKET PROPULSION				
PART – A (SHORT ANSWER QUESTIONS)				
1	Write a short note on liquid propulsion.	Understand	CO3	AAE518:10
2	Define gelled propellants.	Remember	CO3	AAE518:10
3	What is the difference between self-impinging and non-impinging type injectors?	Understand	CO3	AAE518:10
4	Write any one principal function of the propellant feed system.	Remember	CO3	AAE518:11
5	In which case, the pressure feed system gives a vehicle performance superior to the turbo-pump system?	Understand	CO3	AAE518:11
6	Write the names of any two common types of the propellant feed system.	Remember	CO3	AAE518:11
7	Name the principal types of combustion instability in liquid propellant rocket engines.	Understand	CO3	AAE518:12
8	Write an expression for space time-averaged regression rate.	Remember	CO3	AAE518:12
9	Give two applications of hybrid rocket propellants.	Understand	CO3	AAE518:13
10	Why boundary layer theory is important in combustion?	Understand	CO3	AAE518:13
PART – B (LONG ANSWER QUESTIONS)				
1	Discuss the important factors comparing different types of rockets.	Understand	CO3	AAE518:10
2	Explain film cooling and transpiration cooling applied to rocket engine nozzles and turbine blades.	Remember	CO3	AAE518:10
3	What are the advantages of liquid propulsion over Solid rocket propulsion?	Understand	CO3	AAE518:11
4	Explain injection process in liquid propellant rocket system.	Remember	CO3	AAE518:11
5	Describe the events leading to pressure oscillations in a rocket combustor.	Understand	CO3	AAE518:11
6	Explain the merits and demerits of various feed systems.	Understand	CO3	AAE518:12
7	Detail about the peculiar problems associated with the operation of cryogenic engines.	Remember	CO3	AAE518:12
8	Illustrate the combustion mechanism in a hybrid rocket propulsion system with necessary diagrams.	Understand	CO3	AAE518:12

9	With a neat sketch explain the hybrid rocket propulsion system and label the parts.	Remember	CO3	AAE518:13
10	What are the desired properties and the common problems associated with liquid propellants?	Understand	CO3	AAE518:13
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)				
1	Explain the basic configuration of the liquid propellant rocket system using neat sketches.	Remember	CO4	AAE518:10
2	Write a short note on a. Gas pressure feed system b. Turbopump feed system	Understand	CO4	AAE518:10
3	Discuss oxidizers and fuels of liquid propellant rocks. Also, state what is monopropellant and bipropellant?	Remember	CO4	AAE518:10
4	Describe the different types of liquid fuel injectors used in liquid rocket engines with the help of sketches.	Understand	CO4	AAE518:11
5	Explain the combustion instabilities in liquid propellant rockets and the corrective measure to minimize the effect.	Understand	CO4	AAE518:11
6	List out the essential differences from liquid propellant rocket engines to solid propellant rocket. Comment and justify the preferable propellant system for space travel.	Remember	CO4	AAE518:12
7	With the help of neat sketches compare the standard and reverse hybrid systems.	Understand	CO4	AAE518:12
8	Detail the selection criteria of liquid propellant rocket engines and give its importance?	Understand	CO4	AAE518:12
9	What are the limitations of the combustion mechanism theory in hybrid propulsion?	Remember	CO4	AAE518:13
10	Why the initial temperature change causes much less change in the regression rate of a hybrid fuel than in the burning rate of solid propellant. Explain and derive an equation for the regression rate.	Understand	CO4	AAE518:13
UNIT-IV				
Multistage of Rocketing and Separation Dynamics				
Part – A (Short Answer Questions)				
S No	QUESTION	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes
1	Explain about the use of sensors in guidance systems.	Knowledge	CO 4	AAE518.11
2	What are the phases of guidance?	Remember	CO 4	AAE518.15
3	Explain briefly about last phase of guidance.	Knowledge	CO 4	AAE518.11
4	Write about radar control guidance.	Remember	CO 4	AAE518.15
5	What is meant by self contained guidance systems?	Remember	CO 4	AAE518.11
6	Illustrate different types of preset flight paths?	Remember	CO 4	AAE518.15
7	Write about a multi stage rocket.	Remember	CO 4	AAE518.11
8	What is the need of multi staging in rockets?	Remember	CO 4	AAE518.15
9	What is the meaning of rocket flight dispersion?	Remember	CO 4	AAE518.11
10	List out the difference between rockets and missiles?	Remember	CO 4	AAE518.11
Part – B (Long Answer Questions)				
1	Write about the function and purpose of guidance systems incorporated in rockets and missiles.	Remember	CO 4	AAE518.11
2	Write about the importance of accelerometers in guidance systems implemented in rockets and missiles.	Remember	CO 4	AAE518.15
3	Explain about different phases of guidance. Explain about each phase in detail.	Knowledge	CO 4	AAE518.12
4	Describe briefly different classifications of guidance systems used in missiles?	Remember	CO 4	AAE518.14
5	What is a navigational guidance system? Explain about different types of navigational guidance systems.	Remember	CO 4	AAE518.13
6	List out various terrestrial guidance methods that are implemented?	Remember	CO 4	AAE518.12

7	Explain in detail about different stages of launch vehicle that uses two or more rocket stages.	Remember	CO 4	AAE518.13
8	Write about release device performance in rockets.	Remember	CO 4	AAE518.13
9	What is meant by parallel staging? Explain its advantages over other staging techniques.	Remember	CO 4	AAE518.13
10	Compare and contrast the differences between tactical and strategic missiles?	Remember	CO 4	AAE518.13
Part – C (Problem Solving and Critical Thinking)				
1	Justify the statement “A guided missile is usually under the combined influence of natural and man-made forces during its entire flight”.	Evaluate	CO 4	AAE518.11
2	Explain in detail about constant preset flight path and programmed preset flight path.	Understand	CO 4	AAE518.11
3	Explain about the four basic types of variable flight paths in common use.	Understand	CO 4	AAE518.11
4	What are the different tests that are performed for separation mechanisms to establish feasibility of new component or separation-mechanism concepts?	Remember	CO 4	AAE518.11
5	Why don't we use ailerons, rudders and elevators to control the direction of flight in space?	Remember	CO 4	AAE518.11
6	Explain about the working of stage separation in multi stage rockets.	Understand	CO 4	AAE518.11
7	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 ΔV .	Understand	CO 4	AAE518.12
8	A multistage rocket, in the first stage of a two stage rockets=, the rocket is fired from the launch pad starting from rest but with a constant acceleration of 3.50m/s^2 upward at 25 s after launch. This firing uses up all of fuel, however, so after the second stage has finished firing, the only force acting on the rocket is gravity. Ignore air resistance. Find the maximum height that the stage two rocket reaches above the launch pad.	Understand	CO 4	AAE518.12
9	Write in detail about the effect of mass ratio on the flight performance of rockets,	Remember	CO 4	AAE518.13
10	Explain the disadvantages of a single stage rockets.	Understand	CO 4	AAE518.13
UNIT – V				
DESIGN, MATERIALS AND TESTING OF ROCKETS				
PART - A (SHORT ANSWER QUESTIONS)				
1	Name the important materials used for nozzle of the rocket engine.	Remember	CO5	AAE518:15
2	Obtain the classification of space propulsion engines materials.	Remember	CO5	AAE518:14
3	Illustrate the specific material used in the missile combustion chamber.	Understand	CO5	AAE518:14
4	Elucidate the importance of super alloy in rocket system.	Remember	CO5	AAE518:14
5	List out the types of materials used for construction of rocket engine casing?	Understand	CO5	AAE518:15
6	Classify the composite materials and write their uses for different temperature zone.	Understand	CO5	AAE518:15
7	Illustrate the materials of motor in rocket terminology.	Understand	CO5	AAE518:15
8	How the failure can happen without use of proper materials?	Remember	CO5	AAE518:15
9	Elucidate types of rocket testing methods.	Understand	CO5	AAE518:14
10	List out the safety considerations to be taken for rocket testing?	Remember	CO5	AAE518:13
PART - B (LONG ANSWER QUESTIONS)				
1	What is the need of testing of the rocket engine? Write about one testing method for rocket testing.	Remember	CO5	AAE518:13

2	Obtain an equation for the change in velocity for a case with no external surface or body forces acting on the vehicle.	Understand	CO5	AAE518:14
3	Elucidate a brief note on the physical material constituents in rocket casing.	Remember	CO5	AAE518:15
4	Describe briefly about the different materials used for nozzles.	Understand	CO5	AAE518:13
5	Explicit in detail the safety provisions included for the modern test facility of rocket engines?	Understand	CO5	AAE518:12
6	Illustrate briefly about the concept of air augmented rockets with neat diagram.	Remember	CO5	AAE518:13
7	Summarize the difference between super alloy and composite materials. How these two types of materials are used in the solid rocket engine?	Understand	CO5	AAE518:15
Part – C (Problem Solving and Critical Thinking)				
1	Explicit in detail the safety provisions included for the modern test facility of rocket engines?	Remember	CO5	AAE518:14
2	Briefly illustrate about the performance evaluation techniques used for the missile system.	Understand	CO5	AAE518:15
3	Quote the special features of materials for space propulsion system used on the modern missile system propulsion.	Remember	CO5	AAE518:15
4	List the different Rocket testing methods and explain two of them with suitable diagram.	Understand	CO5	AAE518:15
5	Demonstrate the test facilities used for rocket testing. How the testing is performed on liquid rocket system? Explain.	Remember	CO5	AAE518:15
6	“Rocket systems are unreliably in danger”, enumerate your view on this statement.	Understand	CO5	AAE518:14
7	“Aubert and Dual materials are used in the ICBM”. Write the constituents of these materials.	Understand	CO5	AAE518:14
8	“ <i>Rocket engines</i> shall be designed to minimize burst hazards”, Compare the materials used in rockets and missiles with conventional materials.	Understand	CO5	AAE518:15

Prepared by:

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