

COURSE CODE	COURSE TITLE	L	T	P	C
1152AE134	ROCKETS AND MISSILES	3	0	0	3

a) **PREAMBLE :**

This course Rockets and Missiles aims to develop a deep knowledge in the direction of space technology. This course utilizes the basic knowledge and understanding that a student has gained from basic engineering courses toward the practical space application.

b) **PREREQUISITES:**

- Compressible flow aerodynamics
- Rockets and space propulsion

c) **LINKS TO OTHER COURSES:**

- Project work

d) **COURSE EDUCATIONAL OBJECTIVES :**

Students undergoing this course are expected

- To learn the concepts of rocket engines and its application in space mission
- To know about concepts of aerodynamic forces on rocket and missiles, staging of rockets and also equation of motions.

e) **COURSE OUTCOMES :**

On the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Design a preliminary chemical rocket engine	K5
CO2	Compute various types of aerodynamic forces acting on the rocket and missile during the flight	K4
CO3	Determine the various equations of motion used in rocket and missile technology	K6
CO4	Illustrate staging of rockets and its performance estimation.	K5
CO5	Judge the materials for rocket and missile components.	K5

f) **CORRELATION OF COS WITH POS :**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			H			H	H				
CO2	H			H			H	H				
CO3	H			H			H	H				
CO4	H			H			H	H				
CO5	H			H			H	H				

H- High; M-Medium; L-Low

g) **COURSE CONTENTS :**

**UNIT I - SOLID AND LIQUID PROPELLANT ROCKET SYSTEMS**

**L- 9**

Ignition system in rockets-Types of igniters-Igniter design considerations- Combustion system of solid rockets, Design consideration of liquid rocket combustion chamber, injector, propellant

feed lines, valves, propellant tank outlet and helium pressurized and turbine feed systems-  
Propellant slosh - Propellant hammer- Geysering effect in cryogenic rocket engines

**UNIT II - AERODYNAMICS OF ROCKETS AND MISSILES** **L- 9**

Airframe components of rockets and missiles- Forces acting on a missile while passing through atmosphere- Classification of missiles- Method of describing aerodynamic forces and moments- Lateral aerodynamic moment-Lateral damping moment and longitudinal moment of a rocket-Lift and drag forces-Drag estimation- Body up wash and downwash in missiles-Rocket dispersion.

**UNIT III - TWO-DIMENSIONAL ROCKET MOTION IN VACUUM** **L- 9**

Equations of motion-Rocket motion in free space (Tsiolkovsky's equation, Rocket Parameters, Burnout range); Rocket motion in a homogeneous gravitational field (Vertical flight, Constant Pitch angle, Gravity turns)

**UNIT IV - MULTI-STAGE ROCKET** **L- 9**

Nomenclature of the multi-stage rocket-Ideal Velocity of the multi-stage rocket-Vertical ascent in a homogeneous gravitational field and in vacuum (Burnout velocity- Culmination altitude- Vertical ascent of a two-stage rocket)

**UNIT V - MATERIALS FOR ROCKETS AND MISSILES** **L- 9**

Criteria for selection of materials for rockets and missiles, Choice of materials at cryogenic temperatures, extremely high temperatures – Requirement of materials for thermal protection and pressure vessels

**TOTAL = 45 periods**

**h) TEXT BOOKS:**

1. George P. Sutton, Oscar Biblarz, "Rocket Propulsion Elements", 8<sup>th</sup> edition , John Wiley & Sons, 2010
2. J.W. Cornelisse, H.F.R.Schoyer, and K.F.Wakker "Rocket Propulsion and Spaceflight Dynamics" , Pitman, 1979

**i) REFERENCES:**

1. Jack D. Mattingly, "Elements of Propulsion: Gas Turbines and Rockets", AIAA education series, 2006
2. SS Chin "Missile Configuration Design", , McGraw Hill, NY, 1961
3. E. Fleeman, "Tactical Missile Design", 2<sup>nd</sup> edition, AIAA education series, 2006
4. K.J.Ball and G.F.Osborne, "Space Vehicle Dynamics", Oxford University Press, 1967
5. E.R. Parker, "Materials for Missiles and Spacecraft", McGraw Hill, 1982.