GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170104
Semester –VII
Subject Name: Rocket and Missile Technology

Type of course: Professional Elective Course

Prerequisite: Fundamentals of Aeronautical engineering, Flight Mechanics, Aerodynamics, Propulsion

Rationale: Rocket Missile Technology is one of the core areas in the field of aviation as well as Space. The concepts of Rocket Missile Technology are vitally important to the aeronautical engineer.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

Content:

Sr. No.	Content	Total Hrs
1	**FUNDAMENTALS OF ROCKET PROPULSION:** Thrust equation, Rocket Engine parameters, Rocket Engine Nozzles Operating principle, specific impulse of a rocket, internal ballistics, performance considerations of rockets, types of igniters, types of rocket engines. Application of rocket engines	8
2	**LIQUID PROPELLANT LOADING** Propellant loading tolerances, inventory & concept of ullage, Volume versus mass loading & Loading measurement and control, Outage control, Fundamentals of liquid rocket combustion chamber, Injectors, propellant feed lines, propellant tank outlet design.	11
3	**LIQUID AND HYBRID ROCKET PROPULSION:** Salient features of liquid propellant rockets, selection of liquid propellants, various feed systems and injectors for liquid propellant rockets , thrust control and cooling in liquid propellant rockets and the associated heat transfer problems, combustion instability in liquid propellant rockets, Introduction to hybrid rocket propulsion, standard and reverse hybrid systems, combustion mechanism in hybrid propellant rockets, applications and limitations.	10
4	**SOLID ROCKET PROPULSION:** Salient features of solid propellant rockets, selection criteria of solid propellants, propellant grain design considerations , Erosive burning in solid propellant rockets, combustion instability, strand burner and T-burner, applications and advantages of solid propellant rockets.	6
5	**Aerodynamics Design and Characteristics of Missile**: Introduction Missile, Missile Classifications, Types of Design and control, Bodies of	5

	Revolution, Forebody: Conical, Ogival, Hemispherical and other shapes, Mid-Section and Boattail, General Aerodynamics of Airfoil, Aspect ratio, wing planform, Aerodynamics Controls & Jet Controls	
6	**Missile Performance**: Introduction, Friction drag, Pressure drag, induced drag, Interference drag, Boost-Glide Trajectory, Boost – Sustain Trajectory, Long range Cruise Trajectory, Long range Ballistic Trajectory	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30%	**30%**	**20%**	**10%**	**10%**	**0%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Missile Configuration Design by S. S. Chin, McGraw-Hill Book Company, Inc.
3. Propellants and Pressurization system by Elliot Ring.
4. Cornelisse, J.W.., " Rocket Propulsion and Space Dynamics ", J.W., Freeman & Co., Ltd.,London,1982.

Course Outcomes:
After completion of this course students shall be able to

Sr. No.	CO statement	Marks % weightage
1	Describe the working principle of rocket propulsion .	45
2	Explain the advanced propulsion techniques.	15
3	Interpret liquid and solid propellant.	25
4	Know about aerodynamic performance of missile.	15

List of Open Source Software/learning website: https://nptel.ac.in/course.php