AEROSPACE PROPULSION

V Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAEC14	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

Prerequisite: Aircraft Propulsion

I. COURSE OVERVIEW:

Aerospace propulsion focuses on fundamental knowledge of conceptual planetary and solar systems, propulsion, and control systems used in the mission design of launch vehicles. This subject motivates to gain knowledge of chemical rocket propulsion for scientific and practical purposes. The course includes the combustion process, propellants, and various components and applications of chemical rocket propulsion systems. This course deals with fundamental aspects of advanced rockets and the current trends in rocket propulsion.

II. COURSE OBJECTIVES:

The student will try to learn:

- **I** The description of the solar system, basic concepts of orbital mechanics, and spacemission parameters emphasises for analysis of launch trajectory problems.
- **II** The fundamentals of chemical rocket propulsion, types of igniters and performance considerations for long-duration applications.
- **III** The working principle of solid and liquid propellant rockets and gain basic knowledge of hybrid rocket propulsion used for augmenting the thrust of an rocketengine.
- **IV** The governing physics of electric propulsion, Ion propulsion and nuclear rocket thrusters used for comparison with chemical rocket propulsion.

III. III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the equations of various orbits for Launch vehicle ascenttrajectories.	Apply
CO 2	**Classify** the operating principles of rocket engines for determiningthe performance characteristics of various multistage rocket.	Analyze
CO 3	**Discuss propellant** grain design concepts implemented in solid rocketpropulsion for selecting optimal grain design based on requirements.	Understand
CO 4	**Identify** various erosive burning and combution instability performance parameters for determine the burning rate and combutioncharacteristics.	Apply
CO 5	**Compare** different propellant concepts implemented in rocket motor for identifying the optimal combinations based on particular application.	Understand
CO 6	**Make use of** the concepts of electric propulsion systems for selecting the suitable technique as per the mission requirements.	Apply

IV. SYLLABUS:

MODULE-I: PRINCIPLES OF ROCKET PROPULSION (09)

History of rockets, Newton's third law, orbits and space flight, types of orbits, basic orbital equations, elliptical transfer orbits, launch trajectories, the velocity increment needed the thermal rocket engine, SSTO and TSTO, launch assists.

MODULE –II: FUNDAMENTALS OF ROCKET PROPULSION (09)

Operating principle, rocket equation, specific impulse of a rocket, rocket nozzle classification, performance characteristics of rockets, air augmented rockets, pulse rocket motors, static testing of rockets and instrumentation, safety considerations.

MODULE –III: SOLID ROCKET PROPULSION (09)

Salient features of solid propellant rockets, selection criteria of solid propellants, propellant grain design considerations. Types of igniters.

Erosive burning in solid propellant rockets, combustion instability, strand burner and T-burner, applications and advantages of solid propellant rockets.

MODULE –IV: LIQUID AND HYBRID ROCKET PROPULSION (09)

Salient features of liquid propellant rockets, selection of liquid propellants, various feed systems and injectors for liquid propellant rockets, thrust control, cooling in liquid propellant rockets and the associated heat transfer problems, combustion instability in liquid propellant rockets, peculiar problems associated with operation of cryogenic engines, introduction to hybrid rocket propulsion, standard and reverse hybrid systems, combustion process in hybrid propellant rockets, applications and limitations.

MODULE –V: ADVANCED PROPULSION TECHNIQUES (09)

Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.

V. TEXT BOOKS:

1. Turner, M.J.L., "Rocket and Spacecraft Propulsion", MIT Press, 2nd Edition, 1922.
2. Sutton, G.P., "Rocket Propulsion Elements" John Wiley & Sons Inc., New York, 5th Edition, 1993.
3. P Hill, P.G. and Peterson, C.R., Mechanics and Thermodynamics of Propulsion, Addison Wesley, 2nd Edition, 1992.

VI. REFERENCE BOOKS:

1. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.
2. Tajmar, M., "Advanced Space Propulsion Systems", Springer, 2003.
3. Hieter and Pratt, "Hypersonic Air Breathing Propulsion", 4th Edition, 1993.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/101/106/101106082/
2. https://nptel.ac.in/courses/101/104/101104078/
3. https://www.grc.nasa.gov/www/k-12/airplane/shortp.html

VIII. E-TEXT BOOKS:

1. https://www.springer.com/gp/book/9783540692027
2. https://books.google.co.in/books/about/Rocket_Propulsion_Elements.html?id=1Sf6eV6CgtEC&redir_esc=y
3. https://www.pearson.com/store/p/mechanics-and-thermodynamics-of-propulsion / P100000432806 /9780201146592