SPACE PROPULSION

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AAE012	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

I. COURSE OVERVIEW:

An aerospace propulsion system is a device that generates forces to push the aerospace vehicles forward. This course discusses about the various Aerospace propulsive devices in micro level, it includes an overview of different types of propulsive system present in aircraftsand rockets such as turbojet, turboprop, turbofan, IC engine, solid propellant, hybrid propellant and liquid propellant engines. Along with that design and analysis will be discussed on the various parameters and components present in aerospace propulsive system.

II. OBJECTIVES:

The course should enable the students to:

I. Evaluate various space missions, parameters to be considered for designing trajectories and rocket mission profiles
II. Understand the fundamentals of chemical rocket propulsion, types of igniters and performance considerations of rockets.
III. Discuss the working principle of solid and liquid propellant rockets and gain basic knowledge of hybrid rocket propulsion.
IV. Illustrate electric propulsion techniques, ion and nuclear rocket and the performances of different advanced propulsion systems.

III. COURES OUTCOMES:

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

CO 1	**Explain** the different types of air-breathing engines using the by using Brayton cycle for selecting the suitable engine to an aircraft.	Understand
CO 2	**Determine** the performance parameters that will influence the Air-breathing engines by using parameters like SFC, Thrust, Efficienciesequation for improving the range and endurance of the aircraft.	Apply
CO 3	**Select** the functions and geometrical parameters of different types of inlets, nozzles, combustors and afterburners using aerodynamic principles for selecting of suitable design as per the engine specification.	Apply
CO 4	**Make a use of** velocity triangle method to simplify the performanceinstability of the compressor and turbine blades for increasing the efficiency of the engine.	Apply
CO 5	**Utilize the** working principles of solid and hybrid rocket motors usingNewton's second law of equilibrium for simplifying the limitations and performances level of rocket engine.	Apply
CO 6	**Distinguish** the different propellant feed system and injectors byusing equations for thrust vector control for selecting the suitable component in rocket engine.	Analyze

IV. SYLLABUS:

UNIT-I	PRINCIPLES OF ROCKET PROPULSION	Classes: 09

History of rockets, Newtons third law, orbits and space flight, types of orbits, basic orbital equations, elliptical transfer orbits, launch trajectories, the velocity increment needed for launch, the thermal rocket engine, concepts of vertical takeoff and landing, SSTO and TSTO, launch assists.

UNIT-II	FUNDAMENTALS OF ROCKET PROPULSION	Classes: 09
Operating principle, Rocket equation, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations of rockets, types of igniters, preliminary concepts in nozzle less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets and instrumentation, safety considerations.		
UNIT-III	**SOLID ROCKET PROPULSION**	**Classes: 09**
Salient features of solid propellant rockets, selection criteria of solid propellants, estimation of solid propellant adiabatic flame temperature, propellant grain design considerations. Erosive burning in solid propellant rockets, combustion instability, strand burner and T-burner, applications and advantages of solid propellant rockets.		
UNIT-IV	**LIQUID AND HYBRID ROCKET PROPULSION**	**Classes: 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 mechanism in hybrid propellant rockets, applications and limitations.		
UNIT-V	**ADVANCED PROPULSION TECHNIQUES**	**Classes: 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.		

Text Books:

1. Hill, P.G. and Peterson, C.R., "Mechanics and Thermodynamics of Propulsion", 2nd Edition, Addison Wesley, 1992.
2. Turner, M.J.L., "Rocket and Spacecraft Propulsion", 2nd Edition, MIT Press, 1922.
3. Hieter and Pratt, "Hypersonic Air breathing propulsion" 5th Edition, 1993.

Reference Books:

1. Sutton, G.P., "Rocket Propulison Elements" John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.
3. Tajmar, M., Advanced Space Propulsion Systems, Springer 2003.

Web References:

1. https://nptel.ac.in/courses/101106033/
2. https://nptel.ac.in/courses/112106073/
3. https://www.coursera.org/specializations/propulsion.

E-Text Books:

1. https://www.scribd.com/document/63588270/Aerospace-Propulsion-Systems
2. https://as.wiley.com/WileyCDA/WileyTitle/productCd-1118806778.html
3. https://as.wiley.com/WileyCDA/WileyTitle/productCd-1118307984.html
4. https://as.wiley.com/WileyCDA/WileyTitle/productCd-0470824972.html

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