Course code	Course Name	L-T-P-Credits	Year of Introduction
AO302	PROPULSION - II	4-0-0-4	2016

Prerequisite : AO206 Propulsion - I

Course Objectives

- To impart knowledge in non-air-breathing and hypersonic propulsion methods
- To familiarise various propulsion technologies associated with space launch vehicles, missiles and space probes..

Syllabus

Hypersonic air breathing propulsion- Supersonic combustion - chemical rocket propulsion - Flight performance - Air augmented rockets - Pulse rocket motors -Static testing of rockets & instrumentation, safety considerations- solid propellant rockets - liquid propellant rockets - Combustion instability - Cryogenic engines - hybrid rocket propulsion - electric propulsion techniques- Nuclear rocket propulsion - Propellant less Propulsion concept, Photon rocket, beamed energy propulsion, solar sail.

Expected Outcome

The students will be able to

i. Understand Hypersonic propulsion systems
ii. Know the applications and principles of liquid and solid-liquid propulsion systems
iii. Exposed to non-conventional propulsion in rocketry..

Text Books:

1. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers and Distributors, Delhi, 1988.
2. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition, 1993.

References:

1. Hieter and Pratt, "Hypersonic Air Breathing Propulsion", AIAA Education Series, 1994
2. Thomas A Ward, "Aerospace Propulsion System" , Wiley, 2010

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion.	3	15%
	Salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion.	2	
	Engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustors.	3	
	One dimensional model for supersonic combustion using method of influence coefficients.	2	

II	Operating principle – specific impulse of a rocket.	1	15%
	Internal ballistics – performance considerations of rockets – types of igniters.	3	
	Preliminary concepts in nozzle-less propulsion – air augmented rockets – pulse rocket motors.	2	
	Static testing of rockets & instrumentation –safety considerations.	4	
FIRST INTERNAL EXAM			
III	Salient features of solid propellant rockets – selection criteria of solid propellants.	2	15%
	Estimation of solid propellant adiabatic flame temperature - propellant grain design considerations.	2	
	Erosive burning in solid propellant rockets – combustion instability – strand burner and T-burner.	3	
	Applications and advantages of solid propellant rockets.	1	
IV	Salient features of liquid propellant rockets – selection of liquid propellants – various feed systems and injectors for liquid propellant rockets.	3	15%
	Thrust control and cooling in liquid propellant rockets and the associated heat transfer problems.	3	
	Combustion instability in liquid propellant rockets.	2	
	Problems associated with operation of cryogenic engines.	3	
SECOND INTERNAL EXAM			
V	Introduction to hybrid rocket propulsion.	1	20%
	Standard and reverse hybrid systems.	2	
	Combustion mechanism in hybrid propellant rockets.	3	
	Applications and limitations.	2	
VI	Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion.	3	20%
	Nuclear rocket –comparison of performance of these propulsion systems with chemical rocket propulsion systems.	3	
	Future applications of electric propulsion systems.	2	
	Solar sail.	1	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.