SEMESTER 7

ROCKETRY AND SPACE MECHANICS

Course Code	**PEAOT755**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3/5	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Rocketry and Rocket propulsion	**Course Type**	Theory

Course Objectives:

1. The purpose of the course is to introduce students to particle motion and rocket motion in space.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Solar system: Reference frames and coordinate systems, Celestial sphere- The ecliptic- Motion of vernal equinox, Sidereal time Solar time, Standard time, Galilean transformation, Newton's law of gravitation Kepler's law, Estimation of orbital and escape velocity- Many body problem, Lagrange Jacobi Identity, Circular restricted three body problem. Liberation point, Relative motion in the N-Body problem. Two body problem, Satellite orbit relation between position and time Perifocal frame, Lagrange coefficients and points, coordinate transformation, transformation between geocentric equatorial and Perifocal frames, (Numerical problems)	**14**
2	Orbital position as function of time –, Gibbs method of orbit determination from three position vector, Lambert's problem, orbit determination, Orbit determination by Gauss's method, Orbital manoeuvres: - Hohmann Transfer and non-Hohmann transfer, Chase and phasing maneuverer ,(Numerical problems).	**8**
3	Principles of operation of rocket motor – Thrust equation, one dimensional and two dimensional rocket motion in free space and homogeneous gravitational field, description of vertical, inclined and gravity turn	**7**

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	trajectories determinations of range and altitude, simple approximation to burnout velocity, need for multi staging of rocket vehicle, multistage vehicle optimization (Numerical problems)	
4	Stage separation dynamics and separation techniques, aerodynamic jet control methods of rocket vehicles, description of various loads experienced by a rocket passing through atmosphere, drag estimation- wave drag, skin friction drag, form drag and base pressure drag, boat tailing in missiles performance at various altitudes, rocket dispersion-launching problems.	**7**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

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End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain and use basics of solar system and fundamentals of motion of particle in space	**K2**
CO2	Explain different types of orbit and orbital maneuverer and are able to solve complex problems.	**K2**
CO3	Describe the theories and positioning of rockets	**K2**
CO4	Evaluate the concept loads on rockets while moving through the atmosphere.	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	3	2	2	2	-	-	-	-	-	-	-	2
CO3	3	2	2	2	-	-	-	-	-	-	-	2
CO4	3	2	2	2	-	-	-	-	-	-	-	2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Rocket Propulsion Elements	George P Sutton	Wiley	2016
2	Mechanics and Thermodynamics of Propulsion	Hill	Pearson Education	2009
3	The Satellite Experimenter's Handbook	M. Davidoff	American Radio Relay League	1990

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of Astrodynamics	Bate R R, Muller D, and White J E	Dover Publications	1971
2	Modern Astrodynamics Fundamentals and Perturbation method.	Bond V R and Allman M C	Princeton University Press	1996

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/101/105/101105029/
2	https://archive.nptel.ac.in/courses/101/106/101106046/
3	https://onlinecourses.nptel.ac.in/noc20_ae06/preview
4	https://onlinecourses.nptel.ac.in/noc20_ae06/preview

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