COURSE CODE	COURSE TITLE	L	T	P	C
1152AE135	SPACE FLIGHT MECHANICS	3	0	0	3

Course Category:

Programme Elective

a. Preamble :

This course aims to explore and develop a deep knowledge in the direction of space mission, starting from a gravitational ground level to a zero gravity space. This course utilizes the basic knowledge and understanding that a student has gained from the Rocket propulsion towards the practical space mission application.

b. Prerequisite Courses:

Engineering Mechanics, Rocket and space propulsion

c. Related Courses:

Nil

d. Course Educational Objectives :

- To understand the fundamental principles governing ascent and descent missions & their design
- To provide exposure to basic concepts in Celestial Mechanics, Orbital Dynamics and related topics
- To study operating environment for manmade space object and its impact on their design and operation.

e. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic principles governing ascent and descent missions and their design	K2
CO2	Select the space launch vehicle for a prescribed space mission	K3
CO3	Derive the 2-body equations of motion and transform from orbital elements to satellite position and velocity and vice versa	K3
CO4	Apply the orbital mechanics to the earth satellites operation	K3
CO5	Examine stability, disturbed motion of trajectories / orbits.	K3

f.Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			**H**				H				
CO2	H			**H**				H				
CO3	H			**H**				H				
CO4	H			**H**				H				
CO5	H			**H**				H				

H- High; M-Medium; L-Low

f. Course Content :

UNIT-I INTRODUCTION TO SPACE MISSION L-9

Introduction: Space Missions and role of launch vehicles and spacecraft, Historical perspective, Ascent mission: Ascent mission objectives, Mathematical models governing ascent mission, rectilinear and gravity turn ascent trajectories, effect of aerodynamic drag and gravity on ascent mission performance, Descent mission: orbit decay solution, concept of re-entry mission, ballistic and other reentry mechanisms

UNIT-II SPACE LAUNCH VEHICLE PERFORMANCE L-9

Multistage launch vehicles: concept of multistaging, staging solution, sensitivity analysis, series and parallel staging configurations, optimal staging solutions, Launch vehicle attitude motion models, nature of attitude response to atmospheric disturbances.

UNIT-III TWO BODY PROBLEM L-9

Basic orbital solution: Two-body problem solution, Kepler's laws and equation, classical orbital elements, orbit determination from initial conditions, position and velocity prediction from orbital elements , different types of orbits, perturbation due to earth oblateness and solar radiation pressure, non-keplerian formulation and restricted 3-body problem, sphere of activity& Roche limit.

UNIT-IV SATELLITE OPERATIONS L-9

Satellite operations: orbit raising manoeuvre, Hohmann and low thrust transfer manoeuvres, orbit inclination change maneuver, orbit perigee change maneuver, launch to orbit and docking maneuvers, launch window concept, Spacecraft motion: interplanetary motion basics, departure and arrival solutions, planetary transfers, gravity assist trajectories

UNIT-V ATTITUDE DYNAMICS AND CONTROL L-9

Spacecraft attitude motion: Torque-free motion models, effect of energy dissipation on stability of rotational motion, overview of actuation mechanism for attitude control

Total: 45 Periods

Learning Resources

i. Text Books:

1. William E.Wiesel, “Spaceflight Dynamics”, , Createspace, 3rd Edition, 2010
2. J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker, “Rocket Propulsion and Spaceflight Dynamics”, Pitman, 1979

ii. References:

1. “Fundamentals of Astrodynamics and Applications”, David.A.Vellado, Microcosm and Kluwer, 2001
2. “Orbital Mechanics”,John E. Prussing and Bruce A. Conway, Oxford University Press, 2012.
3. "Spacecraft Mission Design”, Charles D.Brown, AIAA Education Series, Published by AIAA, 1998
4. “Orbital Mechanics”, Vladimir A. Chobotov, AIAA Education Series, Published by AIAA, 2002
5. “Space Vehicle Dynamics and Control”, Bong wie, AIAA Education series, 2008
6. “Analytical mechanics of space systems”, HanspeterSchaub , John L. Junkins, AIAA Education series, 2009
7. “Introduction to space flight”, Francis J Hale, Pearson,1994
8. “Introduction to space dynamics”, William T. Thomson, Dover publications, 1986.
9. Pisacane and Moore, ‘Fundamentals of Space Systems’, Oxford University Press, 1994.
10. Sidi, ‘Spacecraft Dynamics & Control’, Cambridge, 1997
11. Wie, ‘Space Vehicle Dynamics and Control’, AIAA Education Series, 1998.
12. Meyers, ‘Elements of Space Technology for Aerospace Engineers’,Academic Press, 1999.