COURSE CONTENT

SPACE ENGINEERING								
VII Semester: AERO								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED63	**Open Elective**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite:								

I. COURSE OVERVIEW:

Space engineering is an interdisciplinary field that encompasses the design, development, and operation of spacecraft and space systems. This course serves as an introduction to the fundamental principles, concepts, and methodologies essential for understanding and working in the space engineering domain. Students will explore key topics related to spacecraft design, mission planning, propulsion systems, orbital mechanics, and space exploration.

II. COURSES OBJECTIVES:

The students will try to learn

I. The mathematical and vector calculus techniques essential for analyzing motion and transformations in aerospace applications.
II. The physical laws and time measurement systems that govern orbital mechanics and spacecraft dynamics.
III. The space environment and its effects on spacecraft operations, including hazards such as space debris and geomagnetic influences.

III. COURSE OUTCOMES:

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

CO 1 Understand the mathematical fundamental of plane motion with radial and transverse components for space applications.
CO 2 Make use of Kapler's law, and Newton's law to obtain the force and momentum with different time standards of the space system.
CO 3 Transform between coordinate systems using rotational matrices.
CO 4 Show different coordinate systems to assess the space and time status using rotational matrices.
CO 5 Illustrate the spacecraft trajectory by using space trajectory equations, escape velocity for correct flight path angle assessment.
CO6 Demonstrate different composition of space environment with space debris conditions to safe guard the active satellite.

IV. COURSE CONTENT:

MODULE-I: MATHEMATICAL FUNDAMENTALS (10)

Vectors and scalars, Dot and cross product of vectors, Derivative of a vector function, Gradient, Integral of a vector function, Plane motion – radial and transverse components, tangential and normal components, Spherical trigonometry laws and applications.

MODULE –II: PHYSICAL PRINCIPLES AND TIME MEASURES (10)

Kepler's laws, Newton's laws, Work and energy, Force and momentum, Impulse and momentum, Law of conservation of total energy, Angular momentum, Universal time, Dynamical time, Julian date, Solar and sidereal days.

MODULE -III: COORDINATE SYSTEMS AND TRANSFORMATION (09)

Two- and three-dimensional coordinate systems, Polar and Cartesian coordinates, Spherical polar coordinates, Inertial and body-fixed coordinate systems

Rotation and rotation matrices, Two- and three-dimensional rotation, Three-angle sets for specifying orientation: Roll-pitch-yaw, Euler angles, Euler parameters.

MODULE-IV: INTRODUCTION TO ATMOSPHERIC AND SPACECRAFT TRAJECTORY (09)

Rocket equation, Staging, Central force motion, Newtonian gravitation, Properties of conic sections, Escape velocity, Two-body motion: energy and velocity on orbit, Classical orbital elements, Velocity azimuth and flight path angle.

MODULE –V: INTRODUCTION TO SPACE ENVIRONMENT (09)

Sun and solar wind, Earth's atmosphere, Ionosphere and communications, Geomagnetic field, Micrometeoroids. Introduction to space debris, Space debris environment in low earth orbit, Debris measurements, Space debris environment in geosynchronous equatorial orbit, Spatial density, Collision hazards associated with orbit operations. Space Debris.

V. TEXT BOOKS:

1. Gerald R. Hintz, "Orbital Mechanics and Astrodynamics – Techniques and tools for space missions", Springer, First Edition, 2015.
2. William T. Thomson, "Introduction to Space Dynamics", Dover Publications, 2000.

VI. REFERENCE BOOKS:

1. William E. Wiesel, "Spaceflight Dynamics", Aphelion Press, USA, Third Edition, 2010.
2. David A. Vallado," Fundamentals of Astrodynamics and Applications", Microcosm and Kluwer, 2nd Edition, 2004.
3. Jerry Jon Sellers, Understanding Space: An Introduction to Astronautics, 3rd Edition McGraw-Hill, 2005
4. J.R.Wertz, D.F.Everett, and J J. Puschell, "Space Mission Engineering: The New SMAD", Microcosm Press, 2011.
5. Jerry Jon Sellers, Understanding Space: An Introduction to Astronautics, 3rd Edition. McGraw-Hill, 2005.

VII. ELECTRONICS RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc19_ae02/preview
2. https://www.mooc-list.com/search/node/civil%20aviation

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation