B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE325: Geodesy and Navigation	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To equip students in an understanding of Fundamentals of Geodesy, Geometric geodesy, satellite geodesy, and the application of physical geodesy in mapping, navigation, and geophysical research.

S. No	Course Outcomes (CO)
CO1	Introduction to Fundamentals of Geodesy
CO2	Physical Geodesy: Gravity Field and Potential Theory. Geoid Modeling and Height Systems.
CO3	Geometric Geodesy: Geometric Relationships on the Ellipsoid. Geodetic Measurements and Computations
CO4	Understanding Satellite Geodesy
CO5	To understand GNSS principles, error sources, and navigation applications.
CO6	To equip students to apply signal processing techniques in navigation and geospatial data analysis.

S. No	Contents	Contact hours
UNIT 1	**Fundamentals of Geodesy**: **Introduction to Geodesy:** Definition, branches, history, and importance of geodesy. **Earth's Shape and Gravity:** Understanding the Earth's shape (geoid, ellipsoid), gravity field, and its relationship to geodesy. **Coordinate Systems:** Horizontal and vertical datums, reference surfaces (geoid, ellipsoid), and coordinate systems (e.g., WGS84, GRS80). **Map Projections:** Introduction to map projections, their purpose, methods, and classification. **Geodetic Datums:** Understanding different geodetic datums and their geometric attributes.	8
UNIT 2	**Physical Geodesy : Gravity Field and Potential Theory**: **Gravity and Potential:** Gravitational law, gravity potential, and equipotential surfaces. **Laplace and Poisson Equations:** Understanding and applying these equations in the context of gravity field modeling. **Normal Gravity Field:** Definition and characteristics of the normal gravity field, including the GRS80 and WGS84 systems. **Anomalous Gravity:** Understanding gravity anomalies and their causes. **Geoid Modeling and Height Systems**: **Geoid Modeling:** Stokes' integral, Koch's formula, Vening-Meinesz formula, and Molodensky's approach. **Spherical Harmonics:** Using spherical harmonics to model the Earth's gravity field. **Height Systems:** Physical and geometric heights, height systems around the world, and the geoid as a vertical reference frame.	6

UNIT 3	**Geometric Geodesy: Geometric Relationships on the Ellipsoid**: - **Geodesic Lines:** The shortest distance between two points on an ellipsoid, **Direct and Inverse Problems:** Calculating coordinates from distances and angles, and vice-versa, **Radii of Curvature:** Understanding the curvature of the ellipsoid along meridians and prime verticals, **Azimuths and Angles:** Determining the direction and angle of lines on the ellipsoid. **Geodetic Measurements and Computations -Triangulation and Trilateration:** Surveying methods for establishing horizontal control networks, **Coordinate Transformations:** Converting coordinates between different reference systems and datums, **Map Projections:** Transforming the Earth's surface onto a flat map, **Error Analysis and Adjustments:** Understanding and minimizing errors in geodetic measurements.	8
UNIT 4	**Satellite Geodesy: Satellite Motion: Orbital Mechanics:** Understanding satellite orbits and their dynamics., **Time Systems:** Different time systems used in satellite geodesy (e.g., UTC, GPS time). **Satellite Methods: Very Long Baseline Interferometry (VLBI):** Precise measurements of satellite positions and Earth rotation. **Satellite Laser Ranging (SLR):** Measuring the distance between satellites and Earth., **Lunar Laser Ranging (LLR):** Measuring the distance between the Earth and the Moon, **Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS):** Satellite positioning using Doppler shift measurements, **Satellite Altimetry:** Measuring the height of the Earth's surface.	8
UNIT 5	**Satellite Navigation** - Fundamentals of GNSS: GPS, GLONASS, Galileo, BeiDou, GPS Signal Structure and Positioning Methods, Differential GPS (DGPS) and Real-Time Kinematic (RTK) Techniques, GPS Data Processing and Accuracy Assessment, Applications of GNSS in Engineering and Mapping, Case Studies: GNSS in Land and Urban Planning.	6
UNIT 6	**Digital Signal Processing** - Basic review of signals, types of classification of signals and systems, Convolution and Correlation of signals, Fourier Analysis in frequency domain – DFT, Filtering techniques in geospatial data analysis - median and Gaussian filtering, Wiener filters for denoising.	6
	TOTAL	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Heiskanen, W. A., & Moritz, H. Physical Geodesy.	(1967).
2	Hofmann-Wellenhof, B., & Moritz, H. Physical Geodesy.	(2006).
3	Elements of Geodesy.	2005
4	Supplementary Resources Online materials (e.g., IAG publications, lecture notes provided by the instructor).	1985
5	Proakis and Manolakis, Digital Signal Processing, PHI Publication.	2007
6	R. Babu, Digital Signal Processing, SciTech Publication.	2011