Complete Knowledge Pack: Satellites & Space Stations

1. What is a Satellite?

A satellite is any object that revolves around a larger body in space. Natural satellites include moons (like Earth's Moon), while artificial satellites are human-made machines launched into orbit. Artificial satellites perform communication, navigation, remote sensing, scientific research, and defense roles.

2. Types of Satellites

• Communication Satellites: Enable TV, radio, internet, telephone networks (e.g., Intelsat, Starlink). • Earth Observation Satellites: Monitor weather, forests, oceans, agriculture (e.g., Sentinel, Cartosat, Landsat). • Navigation Satellites: Provide global positioning (e.g., GPS-USA, Galileo-EU, GLONASS-Russia, NavIC-India). • Scientific Satellites: Space telescopes and cosmic research (e.g., Hubble, James Webb). • Military Satellites: For surveillance, early warning, reconnaissance. • Mini & Nano Satellites: Small satellites like CubeSats used by universities and startups for low-cost space missions.

3. Space Stations

A space station is a habitable artificial satellite where astronauts live and conduct experiments. Examples: • International Space Station (ISS): A joint NASA, ESA, JAXA, CSA, Roscosmos project. • Tiangong (China): Active Chinese modular station. • Skylab (USA) and Mir (Russia): Historical space stations. Uses: Microgravity research, astronomy, biology, materials science, and preparing for interplanetary missions.

4. Where Are Satellites Made?

Satellites are built in aerospace facilities with advanced cleanrooms and test centers. Countries and Organizations: • USA: NASA, SpaceX, Boeing, Lockheed Martin. • Russia: Roscosmos, Energia. • Europe: ESA, Airbus Defence & Space. • China: CNSA, CAST. • India: ISRO (Bengaluru, Hyderabad, Ahmedabad). • Japan: JAXA, Mitsubishi Heavy Industries. Process includes design, integration, testing under vacuum/thermal conditions, and finally launch using rockets.

5. Orbits of Satellites

• Low Earth Orbit (LEO, 200–2000 km): Used for Earth imaging, small satellites, and Starlink internet constellation. • Medium Earth Orbit (MEO, ~20,000 km): Used by GPS and navigation satellites. • Geostationary Orbit (GEO, 36,000 km): Communication satellites, weather monitoring (always above the same spot on Earth). • Highly Elliptical Orbit (HEO): Provides long coverage for polar and regional areas.

6. Applications of Satellites

• Telecommunications & Internet connectivity worldwide. • Weather prediction, climate monitoring, and disaster management. • Precision agriculture for crop health and irrigation. • Urban development and smart city planning. • Defense & intelligence gathering. • Scientific exploration: Observing galaxies, cosmic radiation, black holes. • Navigation and timing services critical for transport, aviation, and banking.

7. Research Challenges

• Managing big data collected from thousands of satellites. • High costs of launch and maintenance. • Space debris and collision risk in crowded orbits. • Weather/cloud interference with optical satellites. • Developing real-time global coverage.

8. Interesting Facts

• The first artificial satellite was Sputnik-1 (USSR, 1957). • The Hubble Space Telescope orbits ~547 km above Earth. • There are more than 9,000 active satellites in orbit as of 2025. • SpaceX's Starlink aims for over 42,000 satellites for global internet. • Satellites burn up when de-orbited unless designed for re-entry. • The ISS is the largest man-made structure in space, visible to the naked eye.

9. References & Resources

1. NASA Earth Science: https://earthdata.nasa.gov 2. ESA Copernicus: https://www.copernicus.eu 3. ISRO Satellites: https://www.isro.gov.in 4. NOAA Satellites: https://www.nesdis.noaa.gov 5. SpaceX Starlink: https://www.starlink.com