SPACE MISSIONS AND INSTRUMENTATION FOR THE SPACE - Dr. Anna Gregorio

Analysis of the space environment: from the study of the Sun, of the Earth atmosphere and of their interaction, to the astro-dynamics with a study of the orbits and an introduction to the characteristics of a space mission. Applications in laboratory and exercises with instrumentation and software.

1. INTRODUCTION TO THE SPACE PHYSICS

Purpose and history of the Space Exploration: Introduction, Communication, Meteorology, Navigation and Geodesic Satellites, Space Physics.

2. THE SUN AND THE ENVINRONMENT SURROUNDING THE EARTH

The Sun: Introduction: Structure and Atmosphere, Solar Wind, Cosmic Rays, Solar Cycle. The Earth Atmosphere: Thermal Structure of the Atmosphere, Composition of the Atmosphere, Temperature and Density, Atmospheric Ozone, Night and Day Airglow. The Ionosphere: Structure of the Ionosphere, Electronic Density, Ionospheric Disturbances, Processes of Electron Production and Removal, Interaction of Radio Waves with Ionosphere, Measurement of Electronic Density from the Space. The Magnetosphere: Earth Magnetic Field, Magnetosphere, Sun-Earth Interaction, Solar and Galactic Cosmic Rays. The Van Allen Radiation Belts: Discovery, Confinement of Charge Particles in Magnetic Fields, Characteristics of the Van Allen Belts, the Aurora.

3. INTRODUCTION TO THE ASTRO-DYNAMICS

Keplerian Orbits: Equations of a Satellite Motion, Motion Constants, Eccentrical Anomaly, Orbital Elements, Equations of Satellite Motion with External Disturbances, Effect of the Earth Tri-axiality, Effect of the Atmospheric Drag, Gravitational Attraction of the Sun and Moon, Perturbations due to the Solar Radiation Pressure. Generalities on Orbits: Progressive and Retrograde Orbits, Satellite Orbital Velocity, Sidereal and Synodic Periods, Orbital Diagrams, Lagrangian Orbits, Interplanetary Spacecrafts. Orbital Change: Hohmann Transfer Ellipses, Orbital Plane Variation, In-orbit Appointment, Launch Windows, Orbit Adjustments. Choice of the Orbit: Introduction, Communications, Radiation and High Energy Particles, Sky Coverage, Effects of the Residual Atmosphere.

4. GEOMETRY OF A SPACE MISSION

Geometry on the Celestial Sphere: Celestial Sphere and Coordinate Systems, Study of the Eclipse from a LEO, Beta Angle, the Earth Geometry from the Space, Apparent Motion of a Satellite from an Earth Observer, Satellites in Geo-synchronous Orbits. Laboratory experiment: Use and Test of Software Dedicated to Orbit and Mission Simulation.

5. PROPULSION AND POWER SYSTEMS IN THE SPACE

Characteristics of the Rocket Engines: Introduction, the Rocket Equations, Multi-stage Rockets, Gravity Atmospheric Drag Effects, Structural Design of a Rocket. Propulsion System: Gas Propulsion, Chemical Propulsion, Liquid (bi-)Propellant Engines, Ion and Plasma Propulsion. Power System: Introduction, Photo-voltaic System, Static System, Dynamic Sources. Laboratory Experiment: Measurement of Solar Cell Efficiency.

7. INTRODUCTION TO THE THERMAL SYSTEM

6. ATTITUDE CONTROL AND DETERMINATION SYSTEM

Navigation and Attitude Control: Introduction, First Navigation Phases, Main Attitude Control Operations, Requirements of an Attitude Control System, Passive Control Systems, Thruster Systems, Reaction and Momentum Wheels, Magnetic Torquers, Attitude Control by Gyroscopes, Evaluation of External Torquers, Manoeuvres, Three Axis Stabilized Satellites. Attitude Sensors: Solar Sensors, Analogical Solar Sensors, Presence Sensors, Digital Solar Sensors, Horizon Sensors, Magnetometers, Stellar Sensors.

7. INTRODUCTION TO THE STRUCTURE OF A SATELLITE

8. INTRODUCTION TO THE TELE-COMMUNICATION SYSTEM