AS107: Science of Rockets (12 lectures in 18 hrs) (A certificate course for high school, UG, PG and PG+ students) Instructors: S. Palit Teaching assistants: S. Chakraborty, S. Biswas, K. Belwal, M. Bisht Mode of Instruction: English

<u>Syllabus</u>

Introduction (1 Lecture) Instructor: S. Palit

Overview of Rocket Science; History and evolution of rocketry; Applications of rockets; Basic Principles - Newton's laws of motion, conservation of momentum; Components of a rocket.

Fundamentals of Rocket Propulsion and Propellants (2 Lectures)

Instructor: S. Palit

Principles of Rocket Propulsion; Thrust and specific impulse; Rocket equations (Tsiolkovsky's equation); Types of Rocket Propulsion Systems - chemical propulsion, electric propulsion, nuclear propulsion; Types of Propellants (chemical) - solid propellants, liquid propellants (bipropellants and monopro pellants), hybrid propellants; Propellant Characteristics - energy content, density, specific impulse; Propellant Storage and Handling.

Rocket Engine and Design (1 Lecture)

Instructor: S. Palit

Components of a Rocket Engine - combustion chamber, nozzle, fuel and oxidizer delivery systems; Thermodynamics of Rocket Engines - combustion processes, heat transfer; Performance Parameters – thrust, specific impulse.

Nozzle Design and Flow Mechanics (1 Lecture)

Instructor: S. Palit

Types of Nozzles - converging-diverging nozzles, Bell nozzles, isentropic flow in Nozzles; Area-Mach number relationship; Choked flow; Expansion and Compression Waves.

Aerodynamics of Rockets (1 Lecture)

Instructor: S. Palit

Aerodynamic Forces on Rockets- Lift, drag and stability, Atmospheric Flight - Subsonic, transonic, and supersonic flight - Mach number regimes, Design Considerations - Nose cone design - Fins and stabilization

Rocket Flight Dynamics (1 Lecture)

Instructor: S. Palit

Phases of Rocket Flight – Launch – Ascent - Orbit insertion, Equations of Motion - Gravity turn - Thrust vectoring, Trajectory Analysis - Vertical and horizontal flight

Orbital Mechanics (1 Lecture)

Instructor: S. Palit

Basics of Orbital Mechanics; Kepler's laws of planetary motion; Types of orbits (LEO, MEO, GEO, HEO); Orbital Maneuvers; Hohmann transfer - Bi-elliptic transfer; Plane changes; Gravity Assist and Slingshot Maneuvers.

Satellite and Payload Considerations (1 Lecture)

Instructor: S. Palit

Satellite Design; Structure; Power systems; Communication systems; Payload Integration; Payload fairing; Vibration and shock considerations; Launch and Deployment.

Advanced Propulsion Systems (1 Lecture) Instructor: S. Palit Electric Propulsion; Ion thrusters; Hall effect thrusters; Nuclear Propulsion; Nuclear thermal rockets; Nuclear electric propulsion; Future Propulsion Concepts; Solar sails; Fusion propulsion.

Rocket Testing and Launch Operations (1 Lecture) Instructor: S. Palit

Testing of Rocket Components - engine testing, structural testing; Pre-Launch Preparations; Countdown procedures; Launch control; Post-Launch Operations; Stage separation; Orbit insertion.

Future Trends and Challenges in Rocket Science (1 Lecture)

Instructor: S. Palit

Emerging Technologies; Reusable rockets; Space tourism; Challenges and considerations; Environmental impact; Cost reduction; The Future of Space Exploration; Mars missions; Interstellar travel.

Sitapur Observatory trip (1 night)

Instructors: Devendra Bisht, Kuldeep Belwal, Mohit Bisht, Shraddha Biswas

Discussion on the observables in the night sky, software guided observation using optical telescopes; handson experience on telescope assembling.