

ROCKETS AND MISSILES (AEPE3012)

Course Description

This course provides a comprehensive study of the design, propulsion, and guidance of rockets and missiles. It bridges the gap between atmospheric flight and space exploration, focusing on the mechanical and thermodynamic principles of high-velocity vehicles.

Course Outcomes (COs)

By the end of this course, the student will be able to:

- Classify various types of missiles and rockets based on their mission and propulsion.
- Calculate performance parameters for solid, liquid, and hybrid rocket motors.
- Analyze the aerodynamic forces and stability of slender bodies at supersonic speeds.
- Evaluate multi-staging requirements and trajectory optimization for space missions.
- Understand and apply guidance laws and control mechanisms for precision intercept.

Module 1: Introduction and Configuration

Classification: Tactical vs. Strategic missiles; Space launch vehicles.

System Components: Airframe, power plant, guidance, and warheads.

Forces: Weight, thrust, lift, and drag; coordinate frames (inertial and body-fixed).

Module 2: Rocket Propulsion

- **Solid Propulsion:** Propellant chemistry, grain configurations, and ignition systems.
- **Liquid Propulsion:** Feed cycles (Gas generator, Staged combustion), bipropellants, and cryogenics.
- **Fundamentals:** Specific impulse, thrust coefficient, and the Tsiolkovsky Rocket Equation.

Module 3: Aerodynamics of Missiles

- **Aerodynamic Loads:** Calculation of lift and drag for slender bodies.

- **Supersonic Flow:** Wave drag and skin friction at high Mach numbers.
- **Stability:** Determination of center of pressure and static margin.

Module 4: Flight Mechanics and Staging

- **Trajectories:** Vertical climb, gravity turns, and orbital insertion logic.
- **Staging:** Analysis of payload fraction and optimal mass distribution across stages.
- **Re-entry:** Thermal protection and atmospheric deceleration.

Module 5: Guidance and Control

- **Guidance Laws:** Proportional Navigation (PN), Command Guidance, and Beam Riding.
- **Control Mechanisms:** Thrust Vector Control (TVC), gimballed nozzles, and aerodynamic fins.
- **Operations:** Pre-launch checks, telemetry, and range safety protocols.

Recommended Textbooks

1. **George P. Sutton**, *Rocket Propulsion Elements*, Wiley-Interscience.
2. **K.P. Mishra**, *Fundamentals of Rocket Propulsion*, PHI Learning.
3. **P. Zarchan**, *Tactical and Strategic Missile Guidance*, AIAA Series.