



## ***Tsiolkovsky Level***

### ***Synopsis***

**Prerequisite:** Student must be concurrently enrolled in or have successfully completed Algebra 2.

**Goals/Description:** The Tsiolkovsky Level course is the application/addition of the student's knowledge base, and the further development of life and workforce skills to include cognitive reasoning, critical thinking, problem-solving, design and development, testing and analysis, documentation, teamwork, collaboration, and leadership.

#### **First Semester**

The first semester is designed to ignite the student's desire to learn and enhance 21st Century Learning skills through hands-on projects throughout the 45 modules. Lectures, labs and projects are designed to teach problem-solving skills and foundational knowledge within the four main energy systems: mechanical, fluid, electrical and thermal. As the semester advances and in-depth learning increases, students are required to design and build three small-scale rockets, each with increasingly more difficult criteria.

#### **Second Semester**

The second semester begins with an introduction/review of the industry approved Research Design and Development Loop (RD&D Loop) which is used for the culminating class project—design and build a rocket to take a 1.0-lb payload to an altitude of 5,280 feet (1-mile).

The students, as a project team, develop the overall vehicle design using computer modeling - the design incorporates all the content mastered in the first semester concerning rocket flight. After being selected to component teams (propulsion, air frame and fins, recovery, etc.), students are instructed about timeline management, critical decision-making, and project management. All component teams develop a timeline for production of their component, then begin the research of problem aspects, including function, mass envelope, simplicity etc. A final design is developed, usually in the form of mathematical calculations, that allow the team to move forward in the design process. The mathematical design is used to develop working drawings representing the design of the component. The team begins researching materials and developing decision matrices based on component function. Material variables include safety, cost, application viability, acquisition time, etc. The team then presents a Critical Design Review (CDR) to the overall project team. If a “thumbs-up” is received from the overall project team, it is time to move forward to the development of the component. If not, redesign is needed until it is accepted. After materials acquisition and individual components are complete, all systems (components) must be integrated to complete the class project. Prior to launch, the vehicle must pass the Flight Readiness Review (FRR) to ensure adherence to all safety guidelines. After vehicle has been tested students enter the final phase of the project by evaluating vehicle performance. Students use a Fault Tree Analysis (FTA) to aid in the writing and presenting of a complete Post Mission Analysis (PMA) to peers, parents, and administration, if available. The PMA is used as the final exam.



## ***Tsiolkovsky Level Scope & Sequence***

### **FIRST SIX WEEKS:**

Module 1.1 Why *SystemsGo*?  
Module 1.2 Responsible Use of Technology  
Module 1.3 Advanced Technology  
Module 1.4 Dimensional Analysis & Significant Figures  
Module 1.5 Quiz #1  
Module 1.6 Energy  
Module 1.7 Force Vectors  
Module 1.8 Force Vector Lab  
Module 1.9 Applied Force Vectors  
Module 1.10 Torque & Mechanical Stresses  
Module 1.11 Quiz #2  
Module 1.12 Newtonian Physics  
Module 1.13 Safety  
Module 1.14 First Generation Rocket Development  
Module 1.15 1st Gen Rocket Test/Flight Test Review  
Module 1.16 Flight Stability  
Module 1.17 Six Weeks Review & Assessment

### **SECOND SIX WEEKS:**

Module 2.1 Flight Stability & Six Degrees of Freedom  
Module 2.2 Quiz #2  
Module 2.3 Gen 2 Rocket Development  
Module 2.4 Gen 2 Flight Readiness Review  
Module 2.5 Gen 2 Flight Profile Prediction  
Module 2.6 Thrust to Weight Relationship  
Module 2.7 Gen 2 Test  
Module 2.8 Gen 2 Post-Test Analysis (PMA)  
Module 2.9 Impulse Momentum Theory  
Module 2.10 Fluids: Defined, Archimedes, Bernoulli

Module 2.11 Quiz #4  
Module 2.12 Fluids: Drag & Lift Forces  
Module 2.13 Resistance  
Module 2.14 Resistance Lab  
Module 2.15 Problem Solving Session  
Module 2.16 Cumulative Review & Assessment

### **THIRD SIX WEEKS:**

Module 3.1 Lab Intro to Modeling/RockSim  
Module 3.2 Gen 3 Rocket Design  
Module 3.3 Gen 3 Rocket Development  
Module 3.4 Gen 3 Flight Readiness Review (FRR)  
Module 3.5 Gen 3 Rocket Test  
Module 3.6 Gen 3 Post-Test Analysis (PMA)  
Module 3.7 Quiz #5  
Module 3.8 Electricity in a System  
Module 3.9 Electrical Circuits  
Module 3.10 Electrical Lab  
Module 3.11 Problem Solving Session - Advanced  
Module 3.12 Cumulative Review & Assessment

### **SECOND SEMESTER:**

Teacher Notes 1st Read  
PBL Project Component Plans and Rubrics  
Module 4.1 Teacher Information  
Module 4.2 Design & Development Loop  
Module 4.3 Personnel and Project Management  
Module 4.4 Safety and Scientific Payload  
Module 4.5 Design – FRR, Motor Systems, Altimeter  
Module 4.6 Launch Day Documentation  
Module 4.7 Post Mission Analysis

\*Curriculum is available in both 6 week and 9 week formats.