Scientific Research and Design
Tsiolkovsky Level
Synopsis

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

Goals: Application of the student's knowledge base, addition of knowledge, and the development of life and work skills - cognitive reasoning, critical thinking, problem-solving, design and development, testing and analysis, documentation, and teamwork 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 in 15 modules supported by teacher-friendly PowerPoints and discussions. Lectures, labs and projects are designed to teach foundational knowledge and problem-solving tools found within the four main energy systems: mechanical, fluid, electrical and thermal. As the semester advances and in-depth learning increases, students are also required to design and build 3 small-scale rockets, each with increasingly more difficult criteria.

Second Semester

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

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. Specific component teams develop a timeline for production of their component, then begin the research phase concerning the problem aspects of their component. Problem aspects include 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 calculations are reviewed by a professional in aerospace industry offering criticism of the calculations but no insight into how it may be approved. The mathematical design is then converted to a working drawing representing the design of the component. The team begins extensively researching materials and developing decision matrices based on component function. Material variables include safety, cost, ability to work with, 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 the integrated to complete the class project. At this point the vehicle must pass the Flight Readiness Review (FRR), prior to launch, 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 aide in the writing and presenting of a complete Post Mission Analysis (PMA). The PMA is used as the second semester final exam.

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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
Module 1-5	Energy
Module 1-6	Force Vectors
Module 1-7	Force Vector Lab
Module 1-8	Vector Demo and Review
Module 1-9	Torque & Mechanical Stresses
Module 1-10	Newtonian Physics
Module 1-11	Safety
Module 1-12	First Generation Rocket Development
Module 1-13	Gen 1 Rocket Test/Flight Test Review (PMA)
Module 1-14	Flight Stability
Module 1-15	Six Weeks Summary and Evaluation

Second Six Weeks

Module 2-1	Flight Stability and Six Degrees of Freedom
Module 2-2	Gen 2 Rocket Development
Module 2-3	Gen 2 Flight Readiness Review
Module 2-4	Gen 2 Flight Profile Prediction
Module 2-5	Thrust to Weight Relationship
Module 2-6	Gen 2 Test
Module 2-7	Gen 2 Post-Test Analysis (PMA)
Module 2-8	Impulse
Module 2-9	Fluids
Module 2-10	Drag and Lift
Module 2-11	Rate
Module 2-12	Resistance
Module 2-13	Resistance Lab
Module 2-14	Problem Solving 101
Module 2-15	12 Weeks Summary and Evaluation

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	Electricity in a System
Module 3-8	Electrical Circuits
Module 3-9	Electrical Lab
Module 3-10	Problem Solving - Advanced
Module 3-11	18 Weeks Summary and Evaluation

Fourth, Fifth and Sixth Six Weeks

Design, Develop, Test, Evaluate