Engineering Design and Problem Solving
Oberth Level
Synopsis

Prerequisite: Tsiolkovsky level

First Semester

Goals: Application of the student's Tsiolkovsky level understanding and learning; the furthered development of 21st Century skills; and the design, development, and testing of a transonic vehicle.

The first semester encapsulates the "early" design aspects of the vehicle's performance and configuration. The students, or project team, will develop a flight profile using Excel. The profile will predict all flight dynamics, determine propulsion performance and stresses that will be applied to the vehicle during testing. By the end of the semester, the students have concluded a strong configuration of the vehicle and have the opportunity to travel to NASA–Johnson Space Center Houston–to present the profile to flight engineers. Flight profiles undergo critique and additional work as needed.

Second Semester

Goals: Application of the student's first semester's understanding and learning; the furthered development of life and work skills; and the final development, testing, and analysis of the test vehicle.

The second semester begins with a review of the industry approved Research Design and Development Loop (RD&D Loop) which will be used to design and build a transonic rocket. The goal is for the vehicle to exceed 344m/s i.e. to break the sound barrier.

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 allows 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.

SYSTEMSGO

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Scope & Sequence

First Six Weeks:	**History of Space Travel**
Week 1	Tsung Dynasty to Congreve
Week 2	Tsiolkovsky, Oberth, and Goddard
Week 3	NACA to NASA
Week 4	Mercury and Gemini Programs
Week 5	Apollo Program
Week 6	Shuttle to Constellation
Second Six Weeks:	**Flight Profile**
Week 7	PE = KE = Instantaneous Velocity
Week 8	Excel Spreadsheets
Week 9	Delta V
Week 10	Drag and the Atmospheric Model
Week 11	Newtonian Physics Applied
Week 12	Mass Properties
Third Six Weeks:	**Components' Designs**
Week 13	Overall Vehicle Configuration, 1st Iteration, Prelim Component Concepts
Week 14	Component Problem Statement Research
Week 15	Component Problem Statement Research
Week 16	Technical Calculations
Week 17	Technical Calculations
Week 18	Mechanical Drafting
Fourth Six Weeks:	**Components' Designs**
Week 19	Working Drawings
Week 20	NASA Flight Profile Review
Week 21	Testing and Analysis
Week 22	Testing and Analysis
Week 23	CDR - Critical Design Review
Week 24	Purchase Orders and Material Acquisition
Fifth Six Weeks:	**Component Acquisition and Fabrication**
Week 25	SAE/Machining Principles
Week 26	Component Fabrication
Week 27	Component Fabrication
Week 28	Component Fabrication
Week 29	System Integration
Week 30	System Integration
Sixth Six Weeks:	**Test Prep**
Week 31	System Integration
Week 32	Flight Readiness Review
Week 33	Vehicle Test
Week 34	PMA - Post Mission Analysis
Week 35	PMA
Week 36	PMA