SYSTEMSGO

Engineering Design and Problem Solving

Senior Level - Oberth/Goddard Levels

Synopsis

1st Semester: Knowledge Bases and Skills

Goals: *application of the student's knowledge base, developed over the first three years, especially their junior year; addition of knowledge; and the furthered development of life and work skills, cognitive reasoning, critical thinking, problem solving, design and development, testing and analysis, documentation, and teamwork and leadership.*

The first semester encapsulates the 'early' design aspects of the vehicle's payload, the vehicle's performance, and the vehicle's configuration. The students, or project team, will begin to develop the flight profile. The profile will predict all flight dynamics and will determine propulsion performance and stresses that will be applied to the vehicle during the testing. By the end of the semester, the project team should have concluded a fairly strong configuration of the test vehicle.

2nd Semester: Project Design/Development

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 design and development project has two levels: getting a scratch built vehicle to achieve transonic velocity; or attempting to loft a 35 pound payload between 80,000 to 100,000 feet.

The students have been selected into component teams and are instructed about timeline management and taught about critical decision making and project management. The teams, specific to component design and development, first develop a timeline for the product development (i.e. IPDS) then enter into a research phase concerning the problem aspects of their component. Some of these aspects are function, mass envelope, simplicity, etc. A final argument is developed, usually in the form of mathematical calculations, to allow the component team to move forward into the design process. The mathematical calculations are reviewed by a professional in aerospace industry offering criticism of the calculations but no insight in to how it might be improved. The mathematical design will then be converted to a working drawing to represent the design of the component. Once the team has developed a mathematical argument and drawing for the design of their component, the team will then begin researching any appropriate material to acquire to develop their component At this point, once a design has been developed and reviewed, and once a material has been evaluated and decided upon, the team will then present a Critical Design Review (CDR) to the other design teams on the project. If the component team gets a 'thumbs-up' from the other teams, then it is time to move forward to the development of the component. If not, then a redesign is needed until accepted by the rest of the teams. Once accepted by the project team, the component team will acquire the material and begin to develop their component based on the team's design and materials, through themselves or with the support of local industry. This is where the Oberth level varies from the Goddard level. Within the Goddard level, all components will be manufactured entirely from scratch; nose cone, oxidizer tank, injection, fuel grain, nozzle, etc. Within the Oberth level, the majority of the components will probably be purchased. At this point, each team will undergo a Flight Readiness Review (FRR) to make sure all components are completed 100% and the vehicle can undergo an 'all-up' configuration. After the teams have completed the CDRs and the FRRs then it is time to develop the Standard Operating Procedures (SOP). These will be procedures the students will adhere to for the testing of their vehicle. After the vehicle has been tested, the students will enter into the final phase of the project by evaluating the performance of the vehicle through a Post Mission Analysis.

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Scope and 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	Prototyping
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	Machining Principles
Week 26	Standard American Engineering (SAE)
Week 27	Tolerances
Week 28	Component Fabrication
Week 29	Component Fabrication
Week 30	Component Fabrication
Sixth Six Weeks:	**Test Prep**
Week 31	SOP - Standard Operating Procedures
Week 32	SOP/SHA - Safety Hazard Analysis
Week 33	FRR - Flight Readiness Review / Vehicle Test
Week 34	PMA - Post Mission Analysis
Week 35	PMA
Week 36	PMA