Introduction to Aerospace Engineering
A Freshman-level Course in Rocketry and Satellite Design
AE 100: Introduction to Aerospace Engineering

• Objective: Introduce incoming freshman students to aspects of aerospace engineering giving them hands-on problem solving design and data collection experience

• Currently: two sections
  – Spacecraft and rocket design
  – Aircraft design
AE 100: Rocket and Spacecraft Design

- Introduction to model rocket design, building and launch
- Satellite (12 ounce CanSat) subsystems
- Introduction to circuitry, electronics and soldering
- Rocket trajectory – Theory and numerics
- Solid propellant rockets: combustion and manufacturing
- Space mission design
- Working as a team
- Engineering ethics
- How to write a technical report?

Fig. 11-1. Simplified perspective quarter-section view of a typical solid propellant rocket motor with a case-bonded, perforated grain and a fixed nozzle. The cylindrical case with its forward and aft domes basically forms a pressure vessel. (Adapted with permission from Reference 11-1.)
Circuit soldering  Rocket construction
Payload Section: Mechanical Components

- Triangular support
- Circular plate
- Payload support plate
- Triangular support
- Circular plate
- Altimeter + camera + timer circuit
- Camera + timer circuit
Payload Section: Electronics

- **Digital Camera**
- **Camera Timer Circuit**
- **Parrot Altimeter**
- **Relay**
- **LM555**

Outputs to Camera
Inputs from Altimeter

Parrot altimeter
Rocket Performance: Theory

\[ V_{R \text{\scriptsize{\text{cst mass}}}}(t) = \frac{T t_b}{m_{\text{Ro}}} \frac{t}{t_b} \]

\[ V_{R \text{\scriptsize{\text{var mass}}}}(t) = -\frac{T t_b}{m_{SP_0}} \ln \left( 1 - \frac{m_{SP_0}}{m_{\text{Ro}}} \frac{t}{t_b} \right) \]

\[ \frac{V_{R \text{\scriptsize{\text{var mass}}}}}{V_{R \text{\scriptsize{\text{cst mass}}}}} = -\frac{1}{\eta} \ln \left( 1 - \eta t' \right) \]

where \( \eta = \frac{m_{SP_0}}{m_{\text{Ro}}} \) and \( t' = \frac{t}{t_b} \)
Rocket Performance: Numerics

Trajectory prediction using Matlab: Altitude vs. time

- Prediction - no drag
- Parachute opens
- Measurements
- Prediction - with drag

Experiment vs. with and no drag
Flight Data Processing

Altimeter data
- Data smoothing
- Numerical differentiation
- Numerical integration

Comparison between computed and measured acceleration histories
“Real” Solid Propellant Rockets

11-point star at head end

Circular sections
Thank you

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