> Welcome to 16.90 iSession ...

➢ Instructor: Turn on Webex ,
and distribute MuddyCards ...

> Students: Please LOG OUT from your
Facebook
Twitter
Google+
Foursquare
Email
Messenger
...etc...
...etc...
...etc...

Review and Reading recap

- Local accuracy — Consistency

$\tau \sim O(\Delta t^?)$

- Global accuracy

$|u(1) - v(1)| \sim O(\Delta t^?)$

- Zero-stability

$\frac{du}{dt} = 0$

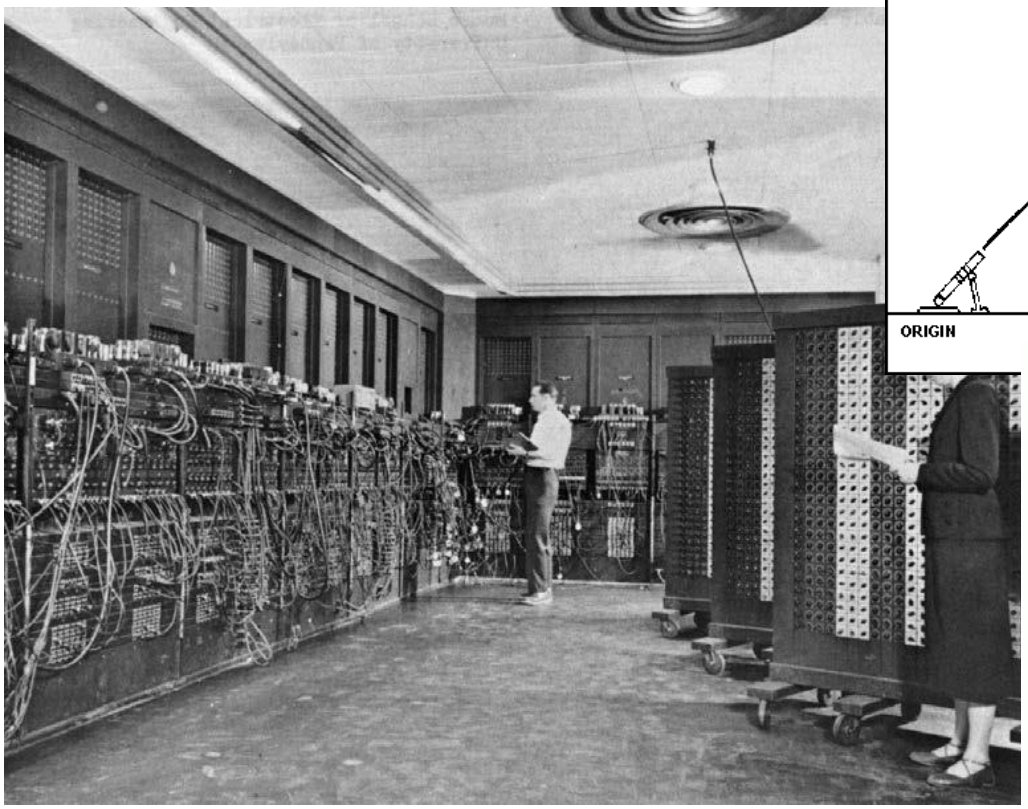
- Eigenvalue stability

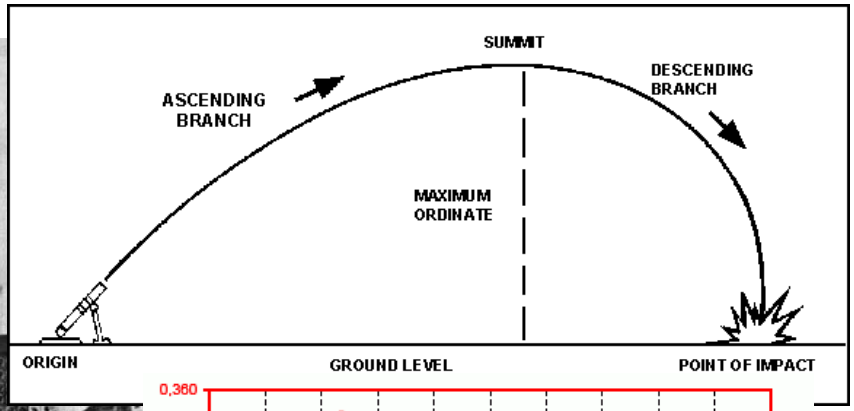
$\frac{du}{dt} = \lambda u$

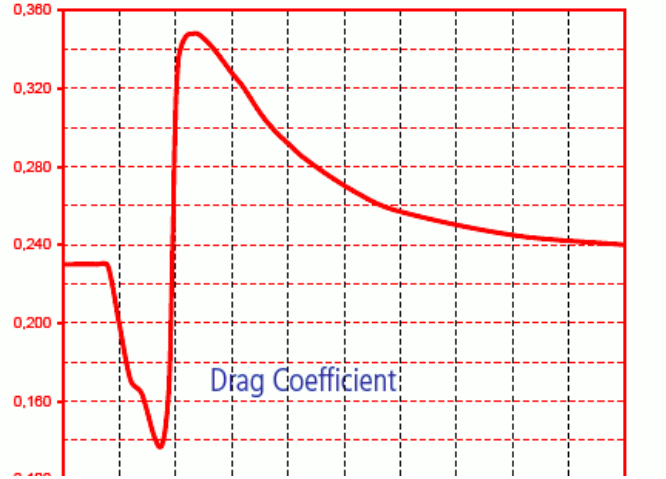
- **Problem: Ballistic trajectory prediction.**
- Mathematically modeling (derive ODEs).
- Numerical solution: forward Euler.
- Numerical solution: midpoint rule.
- $v^{n+1} = -4v^n + 5v^{n-1} + 4\Delta t f(v^n) + 2\Delta t f(v^{n-1})$
- Accuracy, stability and convergence.

Balistic trajectory prediction

- The **first "real" computer**, ENIAC (1946), was designed to perform **numerical simulation** and **help engineers solve problems** in ballistics.

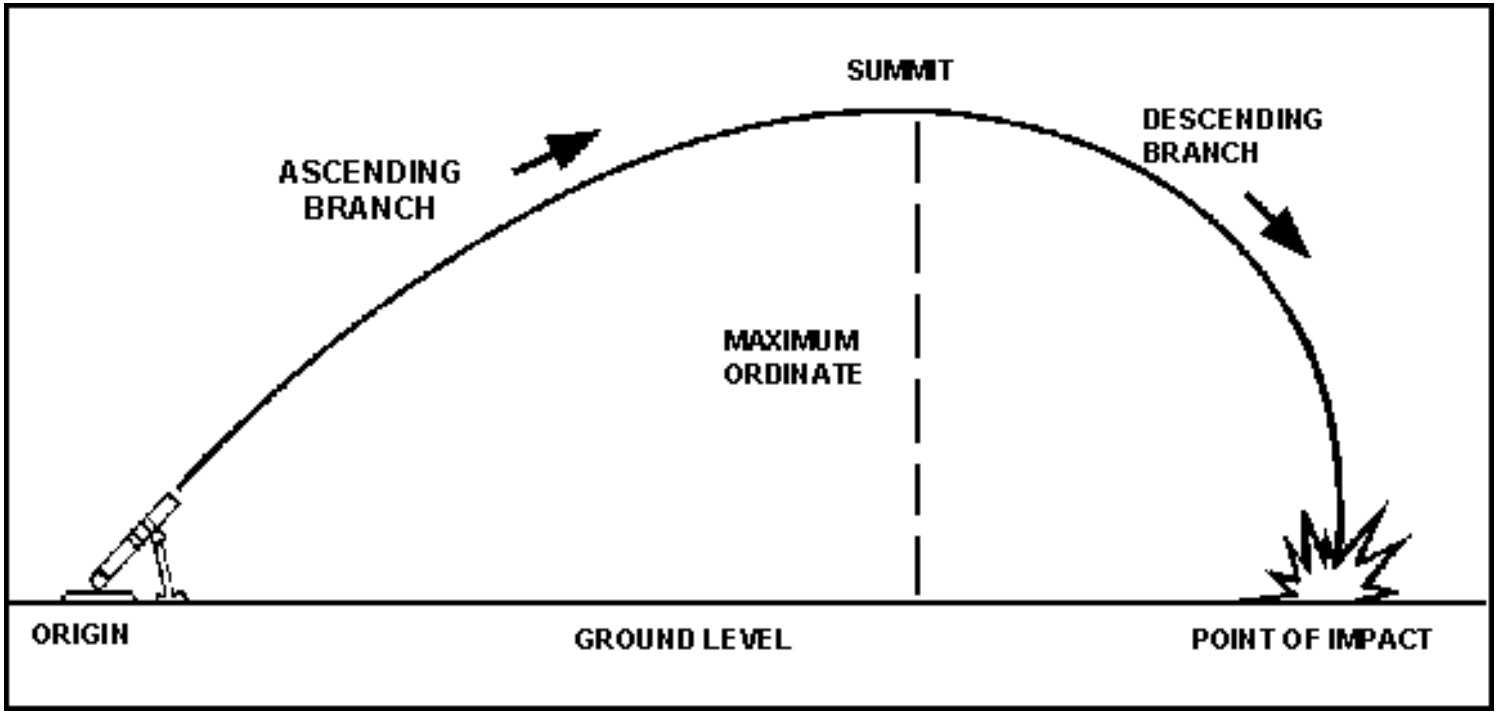






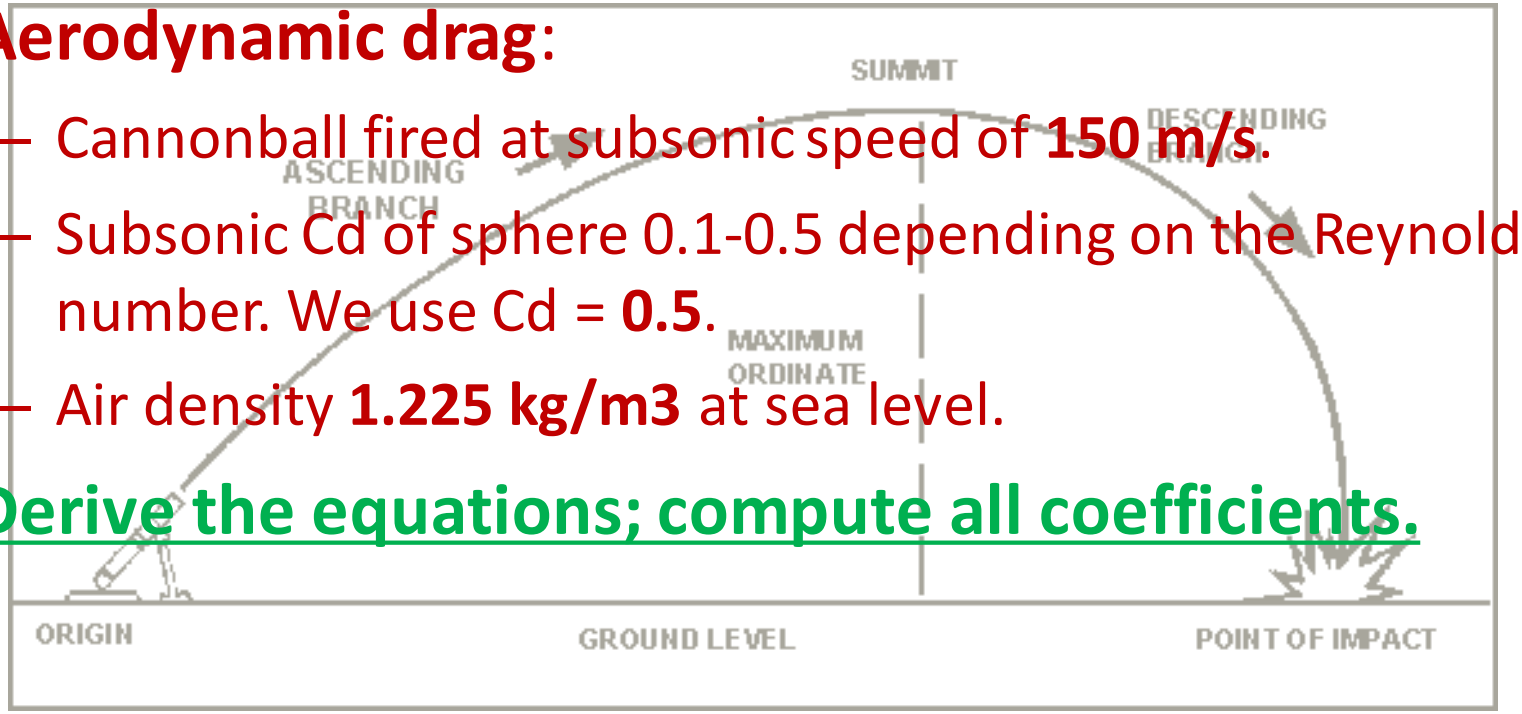
Balistic trajectory prediction

- A motor fires a **3kg**, **10cm** diameter, **spherical** cannonball, at **sea level,** in **standard atmosphere**.
- Given initial velocity, predict point of impact.



* What are the physical processes? *

- A motor fires a **3kg**, **10cm** diameter, **spherical** cannonball, at **sea level,** in **standard atmosphere**.
- Given initial velocity, predict point of impact.
- **Gravity**: standard gravity coefficient 9.807.
- **Aerodynamic drag**:
  - Cannonball fired at subsonic speed of **150 m/s**.
  - Subsonic Cd of sphere 0.1-0.5 depending on the Reynolds number. We use Cd = **0.5**.
  - Air density **1.225 kg/m3** at sea level.
- **Derive the equations; compute all coefficients.**



16.90 Computational Methods in Aerospace Engineering

Spring 2014