**Class 24** – **Numerical Integration Part 1 (Chp. 19)**

ChE310\_SecB\_S2019 / 4.11.19

<http://www.reuelgroup.org/numerical-methods-che-310.html>

**Warm Up Group Activity:** submit to Jared by **2:20 pm**.

The associated file contains recorded altitude values (m) with 1 s time intervals for an unmanned rocket that will be launched into orbit. The safest vertical acceleration a trained pilot can withstand is about 10 x G (98 m/s2).

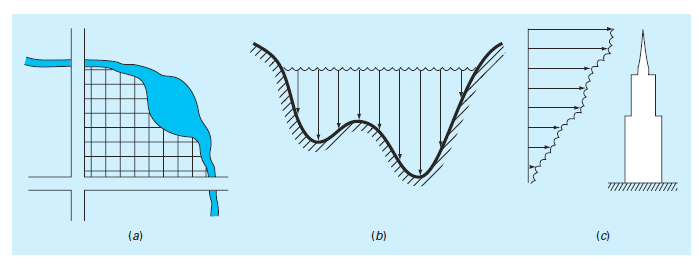
Determine and plot vertical acceleration with respect to time. Would the pilot be safe?

**Outline for Class 24 Lecture**

1. What is integration?

Infinite sum [see pic]

1. Why do we care as engineers?
   1. Summation

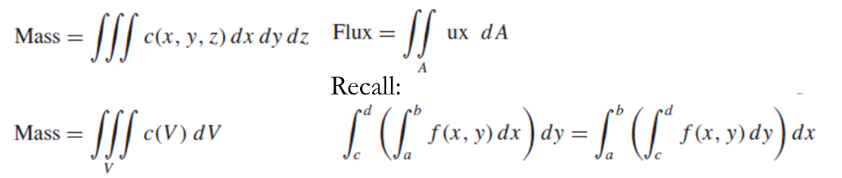


[Also, recall Dr. Reuel’s rockets]

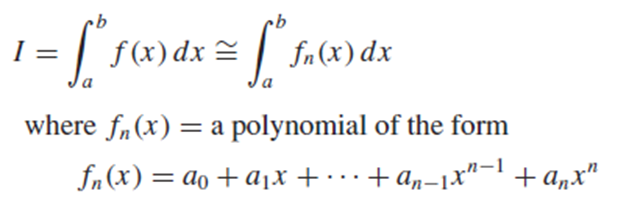
* 1. Mean value



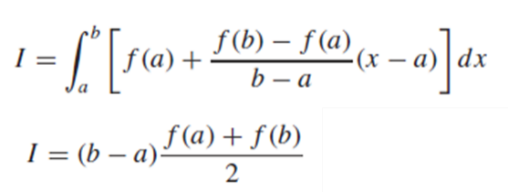
* 1. Control area or volume

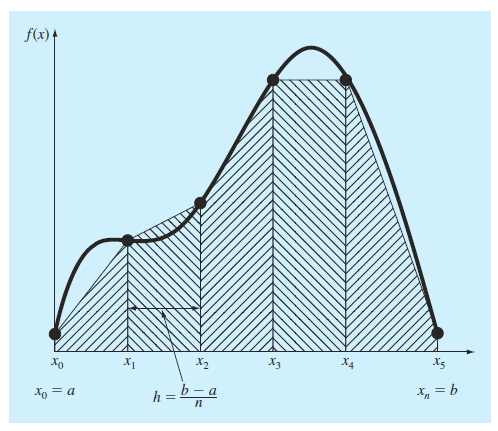


1. Approx: Newton-Cotes Formulas

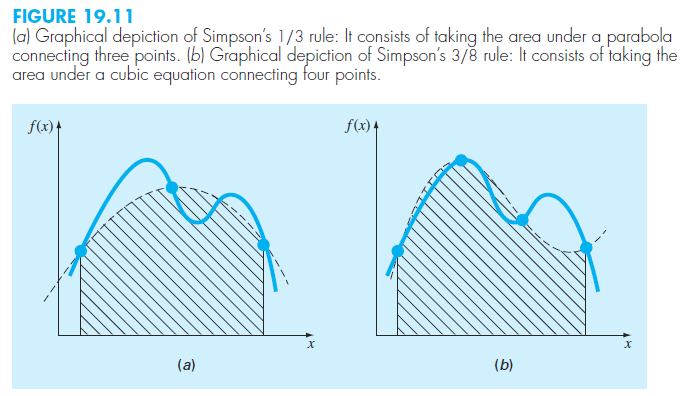
[show pic]

1. Closed vs. open form of approximation
2. Trapezoidal Rule
   1. As number of integration points doubles the error is quartered (see derivation pg. 472)

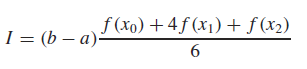




1. Example: calc. impulse from Dr. Reuel rocket engine
2. Higher-Order Polynomials: Simpson Rules



*1/3 Rule*: 3 points, Second order fit (parabola)



* Where x1 is midway between a (x0) and b (x2)
* Error? Just know that it is more accurate than trapezoid (makes sense, follows curves)

*Composite Simpson 1/3*

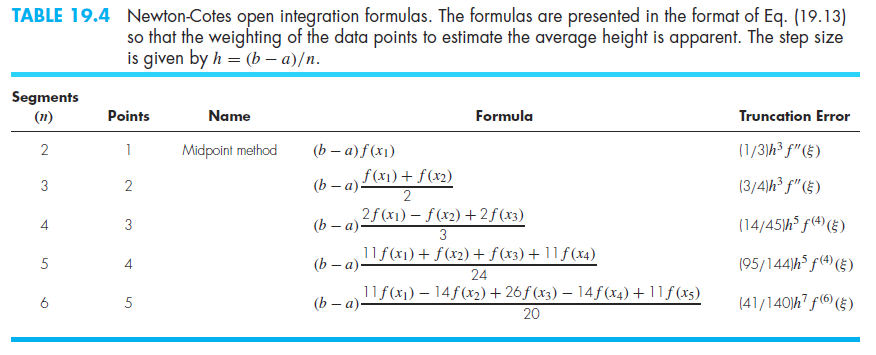
* When to use? Even number of integration points, equally spaced intervals
* [see Picture]

*Simpson 3/8 Rule:* 4 points,

* Third order fit (Lagrange polynomial)
* The 1/3 form is plenty accurate; however, this form can be used to connect a segment that creates odd number of total points. [see pic]

*Higher order (Boole’s rule)* [see pic]

1. Open methods



1. Matlab built in functions (don’t use Chapra **trap**)

**trapz**

**cumtrapz**

**polyint**

1. Examples: 19.4 and 19.8 from text