**Class 21** – **Numerical Integration Part 1 (Chp. 19)**

ChE310\_Sec1\_F2019 / 11.5.19

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

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

I posted some of Jared’s recent DoE data (‘Gluc\_v2’) on the course website. Fit this to a quadratic model (the RLU is the model output). Also make a contour plot of the fit. What model parameters should we eliminate?

**Outline for Class 24 Lecture**

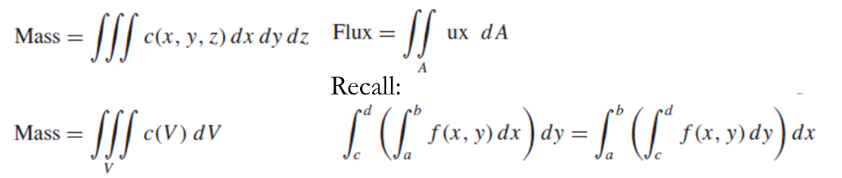
What is integration?

Infinite sum [see pic]

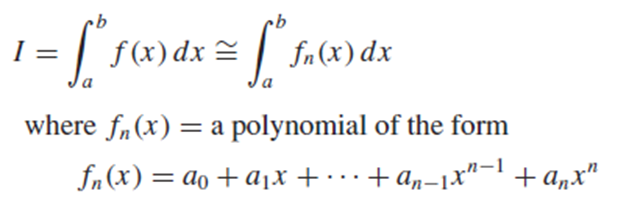
1. Why do we care as engineers? [see pic]
   1. Summation
   2. Mean value



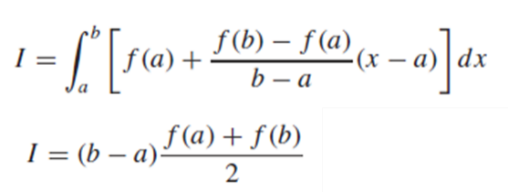
* 1. Control area or volume

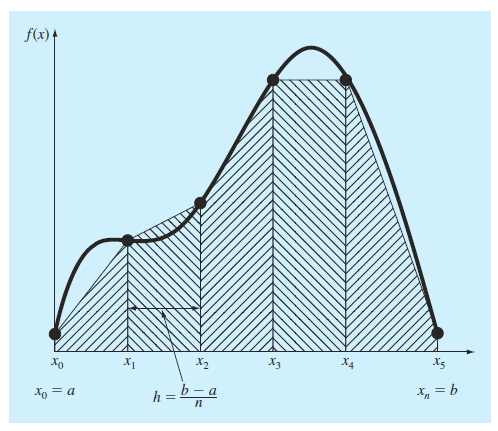


1. Approx: Newton-Cotes Formulas

[show pic]

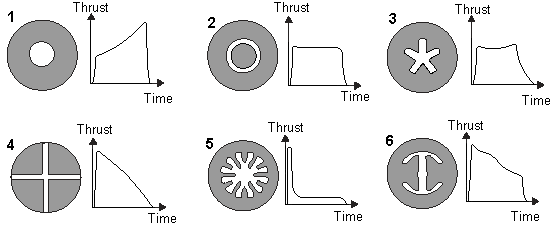
1. Closed vs. open form of approximation
2. Trapezoidal Rule
   1. As number of integration points doubles the error is quartered (see derivation pg. 472)



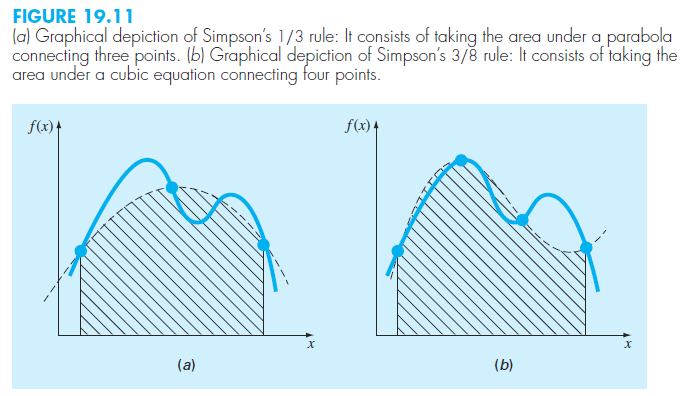


1. Example: calculate impulse from Dr. Reuel rocket engine

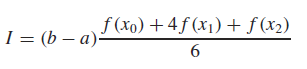
<https://youtu.be/IohvihUgYk8>



1. 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)

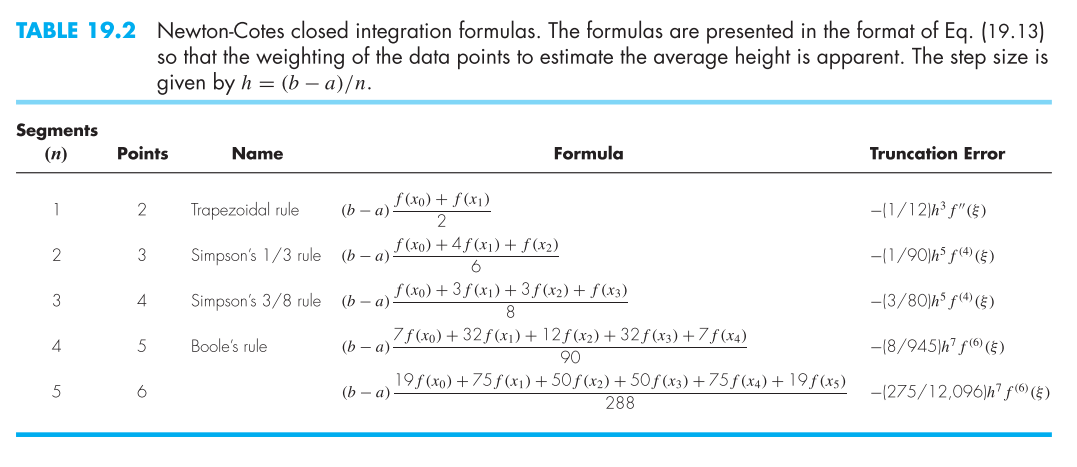
*Composite Simpson 1/3*

* 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 table]



1. Open methods [see pic and table 19.4 in book]
2. Matlab built in functions (don’t use Chapra **trap**)

**trapz**

**cumtrapz**

**polyint**

1. Examples: 19.4 and 19.8 from text