MA 16020 EXAM 2 STUDY GUIDE: CALCULUS II

When to use substitution to integrate?

- **When you have something containing a function (which we call u) and that something is multiplied by the derivative of u.**

  Ex. $\int f(u(x)) \cdot u'(x)\, dx = \int f(u)\, du$

- **How do you use substitution?**
  - **Determine if there is an inner function and call that u.**
  - **Take the derivative of u. So you have**

    $$du = u'(x)\, dx$$
  - **Solve for dx.**
  - **Transform the integral using u and dx.**

When to use partial fraction decomposition to integrate?

- **When you have a fraction with polynomials on the numerator and denominator, and substitution doesn't work.**

- **How do you use partial fraction decomposition?**
  - **Decompose the fraction using the steps outlined in the Handout, METHOD OF DECOMPOSING INTO PARTIAL FRACTIONS.**

- **Note:** **Some integrals will yield $ln|?|$ and others will need a substitution.**

When to use by parts to integrate?

- **When all else fails**

- **How do you use by parts?**
  - **Choose u to be the one to differentiate**
    - **Recall the acronym that tells how to choose u.**

      L – Logarithmic

      A – Algebraic (like polynomials)

      T – Trigonometric

      E – Exponential
  - **Choose dv to be integrated**
  - **Determine du and v and apply the following formula:**

$$u \cdot v - \int v\, du$$

- **Note:**

  1. **You may have to do a substitution within your problem.**
  2. **You may have to apply by parts more than once.**

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An <u>improper integral</u> is when
(1) we have $\pm\infty$ in the bounds, or
(2) we have a discontinuity within the bounds
↓
Check if the integrand is undefined and check if that value is in the interval.

When computing them, rewrite with a limit

<u>ex.</u> $\int_0^\infty e^{-x}\,dx = \lim_{N\to\infty} \int_0^N e^{-x}\,dx$

To review limit check MA 16020 Exam 2 Study Guide: Cal 1.

<u>Area Between Two Curves</u>

The area between two curves can be described two ways:

$A = \int_a^b (\text{Top} - \text{Bottom})\,dx$ → You want $y = \text{Something}_x$ for Top and Bottom

or $A = \int_c^d (\text{Right} - \text{Left})\,dy$ → You want $x = \text{something}_y$ for Right and Left

<u>Volume of Solids of Revolution</u>

Read the problem to see if a particular method is asked for. Plus try to draw the regions.

When the region "hugs" the line of rotation $\Rightarrow$ Disk

- x-axis $\Rightarrow$ dx problem $\Rightarrow$ $V=\int_a^b \pi(f(x))^2\,dx$
- y-axis $\Rightarrow$ dy problem $\Rightarrow$ $V=\int_c^d \pi(g(y))^2\,dy$
- the line $y=\#$ $\Rightarrow$ dx problem $\Rightarrow$ $V=\int_a^b \pi(f(x)-\#)^2\,dx$
- the line $x=\#$ $\Rightarrow$ dy problem $\Rightarrow$ $V=\int_c^d \pi(g(y)-\#)^2\,dy$

When there is a "gap" between the region and the line of rotation $\Rightarrow$ Washer

- x-axis $\Rightarrow$ dx problem $\Rightarrow$ $V=\int_a^b \pi(R^2-r^2)\,dx$
- y-axis $\Rightarrow$ dy problem $\Rightarrow$ $V=\int_c^d \pi(R^2-r^2)\,dy$
- the line $y=\#$ $\Rightarrow$ dx problem $\Rightarrow$ $V=\int_a^b \pi\left[(R-\#)^2-(r-\#)^2\right]dx$
- the line $x=\#$ $\Rightarrow$ dy problem $\Rightarrow$ $V=\int_c^d \pi\left[(R-\#)^2-(r-\#)^2\right]dy$

Where R is the farthest from the line of rotation and r is the closest to the line of rotation