This file intends to sum up the techniques of integration using the *Fundamental theorem of Calculus, II*. Namely, the following techniques apply if you intend to make your integrals look like the integrals from your table on Page 392. All the examples/exercises will be written in terms of indefinite integrals. Here is the general order of your thinking process:

1. Simplify the integrand. Use linearity if there is a piece you can integrate. *Remind you:*
   $$\int f(x)g(x)dx \neq \int f(x)dx \cdot \int g(x)dx.$$
   Example: $x = \int 1dx = \int x\frac{1}{x}dx \neq \int xdx \cdot \int \frac{1}{x}dx = \frac{1}{2}x^2 \ln(x).$

2. Look for ugly parts (i.e. compositions of functions) and try a u-substitution.

3. Classify integrand by its form:

   - rational functions: long division, partial fractions. Section 7.6
   - products of different elementary functions: integration by parts. Section 7.1
   - $\sqrt{\pm(\alpha x + \beta)^2 \pm a^2}$: trig substitution. Complete the square first! Section 7.3.
   - $\int \sin^m(x)\cos^n(x)dx$, $\int \tan^m(x)\cot^n(x)dx$: u-sub depending on the power of the trig functions (there are exceptions). Section 7.2

4. Keep trying. You might need to do multiple steps/multiple methods. If you are given definite integrals, you can use area under curves or Riemann sums.

5. Move on to the next problem.

Exercises:

1. Four integrals that look similar but solved with different methods
   - $\int \frac{1}{x}dx$
   - $\int \frac{1}{x^2}dx$
   - $\int \frac{1}{x^2 + 1}dx$
   - $\int \frac{x}{x^2 + 1}dx$

2. Easy
   - $\int \tan^3(x)\sec(x)dx$
   - $\int x^2 \ln(x)dx$

3. Medium

- $\displaystyle \int \frac{\sqrt{x^2 - 1}}{x^2} dx$

- $\displaystyle \int \frac{x^2 + 1}{x^2 - 2x - 3} dx$

4. Hard

- $\displaystyle \int y^2 (\ln y)^2 dy$

- $\displaystyle \int \frac{x + 1}{\sqrt{5 + 4x - x^2}} dx$

- $\displaystyle \int \frac{\cos(x)}{4 - \sin^2(x)} dx$

- $\displaystyle \int \frac{\ln(\tan(\theta))}{\sin(\theta)\cos(\theta)} d\theta$

- $\displaystyle \int \frac{x^2}{\sqrt{x + 2}} dx$

- $\displaystyle \int \sqrt{x} e^{\sqrt{x}} dx$

- $\displaystyle \int \frac{\arctan(\sqrt{t})}{\sqrt{t}} dt$

5. All problems in Section 7.5. Just do them while you watch Netflix!