Math 295: Differential Equations
Calculus Review for DEs

name: _____
date: _____

To be successful in Differential Equations, you need to be able to differentiate and integrate quickly and reliably. To that end, please complete the following problems to the best of your ability, and have them ready submitted through Canvas by the first day of class, February 9, 2021, at 1835 hrs[1].

Derivatives and Differentiation

Use your old calculus book[2] to review the basic concepts and formulas for differentiation. Topics of particular interest include...

- Differentiation of polynomial, radical, trigonometric, inverse trigonometric, exponential, and logarithmic functions

  1. Calculate y' and simplify[3] the result.

  (**a**) $y = 5x^3 - 3x^2 + \sqrt[7]{x^3}$

  (**b**) $y = 3\sin(x) - \tan(x) + 2\sec(x)$

- Differentiation of product, quotient, and composite functions, *i.e.* the product rule, the quotient rule, and the chain rule

  2. Calculate y' and simplify the result.

  (**a**) $y = \left(3x^2 - x^5\right)^4$

  (**b**) $y = \sqrt{\arctan(x)}$

  (**c**) $y = \left(\sin^{-1}(3x)\right)^2$

  (**d**) $y = \sqrt{\cos\left(\sqrt{x}\right)}$

  (**e**) $y = \tan\left(\dfrac{t}{1+t^2}\right)$

- Implicit differentiation

  3. Calculate $\frac{\mathrm{d}y}{\mathrm{d}x}$ and simplify the result.

  (**a**) $y + x\cos(y) = x^2 y$

  (**b**) $\sin(xy) = x^2 - y$

- Indeterminate forms and L'Hospital's Rule

  4. Find the limit.

  (**a**) $\lim\limits_{x\to 0} \dfrac{x - \sin(x)}{x - \tan(x)}$

  (**b**) $\lim\limits_{x\to 0} \dfrac{\mathrm{e}^x - \mathrm{e}^{-x} - 2x}{x - \sin(x)}$

[1] Yes, you can figure out 24-hour time.
[2] What? You sold it? All that wonderful knowledge for a couple of dollars? Plenty of resources online for you to use....
[3] Combine like terms and rational expressions, FACTOR, etc.

Definite and Indefinite Integrals and Integration

You must *know* the basic forms for antiderivatives. **This list**[4] from Calc I & II is a good reminder of what you need to know. Again, use your old calculus book to review the basic concepts, formulas, and techniques of integration. Topics of particular interest include...

- Basic integral forms

  5. Find the indefinite integral.

  (a) $\displaystyle\int \sqrt{x^3} + \sqrt[3]{x^2}\,\mathrm{d}x$ **(b)** $\displaystyle\int \sec(t)\left(\sec(t)+\tan(t)\right)\,\mathrm{d}t$

- Evaluation of definite integrals with the Fundamental Theorem of Calculus (FTC)

  6. Evaluate the integral.

  (a) $\displaystyle\int_1^2 \frac{1}{x^2} - \frac{4}{x^3}\,\mathrm{d}x$ **(b)** $\displaystyle\int_0^{\pi/4} \frac{1+\cos^2(x)}{\cos^2(x)}\,\mathrm{d}x$

- u-substitution

  7. Evaluate the integral.

  (a) $\displaystyle\int \cos^4(\theta)\sin(\theta)\,\mathrm{d}\theta$ **(b)** $\displaystyle\int_0^1 x\mathrm{e}^{-x^2}\,\mathrm{d}x$

- Integration by parts

  8. Evaluate the integral.

  (a) $\displaystyle\int \ln(x)\,\mathrm{d}x$ **(b)** $\displaystyle\int t\mathrm{e}^{-3t}\,\mathrm{d}t$

- Integration of powers of trigonometric functions

  9. Evaluate the integral.

  (a) $\displaystyle\int \cos^3(\theta)\sin^2(\theta)\,\mathrm{d}\theta$ **(b)** $\displaystyle\int \tan^2(x)\,\mathrm{d}x$

- Integration by trigonometric substitution

  10. Evaluate the integral.

  (a) $\displaystyle\int \sqrt{1-4x^2}\,\mathrm{d}x$ **(b)** $\displaystyle\int_0^3 \frac{x}{\sqrt{36-x^2}}\,\mathrm{d}x$

- Integration by partial fractions

  11. Evaluate the integral.

  (a) $\displaystyle\int \frac{10}{(x-1)(x^2+9)}\,\mathrm{d}x$ **(b)** $\displaystyle\int \frac{5x+1}{2x^2-x-1}\,\mathrm{d}x$

[4] In case you've printed this document (and don't do that again): https://sccollege.edu/Faculty/RScott/Documents/185_Deriv's_and_Int's_from_Calc_I.pdf