Memorization Track for Calculus 1A / 1B

Discussion of the Role of Memorization in Calculus I

Students often ask (usually just before a test), "What do I need to memorize?" The underlying assumption is that mathematics can be mastered, in large part, through memorization. You might assume that if you memorize all the formulas just before the test, you will be an A student. But success in mathematics requires a combination of **knowing the facts/formulas** and being able to **recognize key patterns and structures** and **understanding/insight**. If you eliminate any one of these, your results will be substantially diminished.

Solving problems in mathematics requires recognition of their structures and how various mathematical methods can be applied. Thus, developing the ability to **recognize patterns and structures,** is one of the most important skills in mathematics. Exposure to numerous problems and putting in many hours of practice is the key to building up both your ability to recognize these patterns/structures and building your understanding/insight. With these key elements in place, and having common formulas and identities (the required tools) **both understood and memorized,** ensures that you can solve problems quickly and confidently.

So, in parallel with teaching the concepts and methods of Calculus, **we require that students develop a mental library of the key facts and relationships needed to efficiently solve typical problems**. The sooner this mental library is established the better. The schedule outlined here is the **minimum** schedule that students must follow. **Lawyer's caveat:** Nothing in this summary exempts you from any requirement to learn and develop skills related to any material taught in class or more rudimentary knowledge not specifically listed.

Developing a solid understanding of key concepts can reduce (but not eliminate) the need for memorization. For example, should you memorize the value of $\csc(5\pi/3)$ or should you become skilled at rapidly deriving the value (e.g., via a sketch of the unit circle)? It is your choice, but make sure you can come up with the value of any of the six trigonometric functions for any of the 16 standard angles. Similarly, should you memorize the formulas for $\cos(2x)$ and $\sin(2x)$, or do you just memorize the formulas for $\cos(x \pm y)$ and $\sin(x \pm y)$, and then, using the + sign, set $y = x$? It is up to you. Do you memorize the identities involving $\tan(x)$ and $\sec(x)$ or $\cot(x)$ and $\csc(x)$, or do learn how to derive them from $\sin^2(x) + \cos^2(x) = 1$? Again, it is up to you. Just make sure you can rapidly access all of the relationships listed by the dates required. **Quizzes and tests will presume you have acquired this knowledge once each date is passed.**

Note that this list takes many items for granted. For example, the multiplication tables are not listed nor are many basic relationships of elementary geometry. **The list is selective and is not exhaustive**. It should be considered a good "minimum tool kit" focused on the most useful items encountered in Calculus I (which become the basis for Calculus II) and nothing more. You should enlarge this minimum knowledge base as you practice solving problems.

So **memorize these items (or learn how to quickly derive them)** to make sure that you can access them quickly when needed, but also do as many problems as possible to build your ability to recognize the underlying **patterns and structures** of problems and to build your **understanding/insight**.

Your success depends on all three!

Memorization Track ("No Later than" Schedule)

(Note: Any content taught in class, whether presented before or after these dates, is *IN ADDITION* to this list)

Latest Date (8AM)	Content to be Memorized or Able to be Derived (Note: **Understanding** will dramatically reduce the need for rote memorization)	References (UML 3rd Edition)
Sept 12th	**Basic rules of algebra including all basic operations with fractions, common factoring forms (including $a^2 - b^2$ and $a^3 \pm b^3$). Basic properties of plain geometry, Pythagorean Formula, and formulas for the perimeter, area, and volumes of common geometric objects. Interval notation.**	Basic Algebra Guide Sec. 1 & 2, Text iii, 1st column of pg iv, top of pg vi, and page AP-3 of Hass.
Sept 26th	**Properties and formulas for linear and quadratic equations including standard forms, y-intercept, x-intercept(s)/root(s), vertices, and plots. Also, meaning of roots/radicals, and laws of exponents.**	Dugopolski pgs 36-42 and pgs 114-119, Basic Algebra Guide Sec 3&4.
Sept 28th	**Definition of radian measure, arc length formula ($s = r\theta$), and formula for converting deg to/from radians ($Deg/180 = Rad/\pi$). Six trigonometric functions: Definitions, plots, domains, ranges, roots, values at standard angles, and basic identities (See summary of basic identities below this table)**	Text vii, identities summarized below, and Dugopolski pgs 209-212
Oct 5th	**Exponential functions (base <1 and >1), value of a^0, slope of e^x at x=0, and properties of higher order polynomials (behavior at infinity, possible number and minimum number of real roots, potential shapes). Be able to sketch the exponentials and know the approximate value of e^n for $n = 0, \pm 1, \pm 2, \pm 3$ from which you can derive $n = \pm 4, \pm 5, \pm 6, \ldots$**	Plots top row pg xiii and plots on page xi. Your instructor will discuss general properties of higher order polynomials.
Oct 30th	**Laws of limits, the limit definition of the derivative, and the Product and Quotient Rules**	Hass Thm 1 limit Laws (pg 62) and "General formulas" on page R-2 (back of book)
Nov 13th	**Derivatives of trigonometric and exponential functions**	Trig & Expon rules R-2
Nov 20th (Exam II)	**Chain rule and its application in conjunction with the Product and Quotient Rules for any algebraic combination of functions previously taught.**	"Outside-Inside" Rule pg 158 & Thm 2 pg 157
Dec 10th	**Implicit differentiation**	Section 3.7
Feb 1st	**Definition of inverse functions and their relationship to their corresponding original function (including domains and ranges), definition/meaning of logarithms, plots of log functions for bases <1 or >1, laws of logarithms including change of base formula, value of log(1) or $\log_a(a^q)$. Definition of inverse trig functions, plots for $\sin^{-1}(x), \cos^{-1}(x), \tan^{-1}(x)$, and values of any trig function of any inverse trig function (i.e., What is $trig_1(trig_2^{-1}(a/b))$?)**	Dugopolski Section 1.9 and 3.5 plus Hass 1.6 (especially Hass Thm. 1 pg 43 and the boxed in materials on Hass pg 44)
Feb 8th	**Derivative formulas for logarithms and for $\sin^{-1}(x), \cos^{-1}(x), \tan^{-1}(x)$**	See handout (on website) for derivation method.
Apr 5th	**L'Hospital's Rule**	Hass Sec 4.5, Thm 6, 247
Apr 12th	**The formula for Newton's Method and definitions of Hyperbolic functions**	Hass page 267 & 420
Apr 17th	**Anti-derivatives including those yielding $\sin^{-1}(x), \cos^{-1}(x), \tan^{-1}(x), \ln(\lvert x \rvert)$**	Hass Appendix pg R-2
May 6th	**Meaning/conventions of sigma notation & general meaning of the definite integral and its notation plus rules satisfied by definite integrals.**	Pg 299 & definition pg 306 and Table pg 309

- **Trigonometric identities:** $\sin^2(\theta) + \cos^2(\theta) = 1$, $\tan^2(\theta) + 1 = \sec^2(\theta)$ and $1 + \cot^2(\theta) = \csc^2(\theta)$. Also, know the identities for $\sin(x \pm y)$ and $\cos(x \pm y)$ [implying formulas for $\sin(2x)$ and $\cos(2x)$, and that $\sin^2(x) = (1 - \cos(2x))/2$ and $\cos^2(x) = (1 + \cos(2x))/2$].
- **Triangle identities:** Law of Sines and Law of Cosines (see Dugopolski Section 3.9)