(Proposed) Course Calendar

CSE 1400 & MTH 2051 Discete Mathematics

Spring 2018 (January 4, 2018)

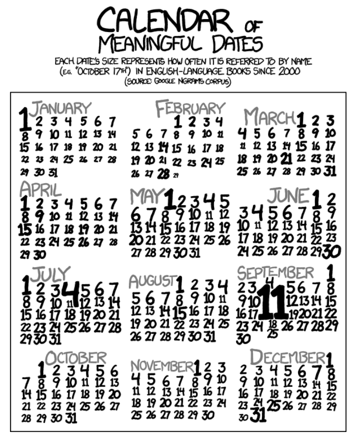
This course calendar predicts when class events are expected to happen. It is not written in stone. Nothing is certain. Things may change. Pay attention. Colors are used to indicate an exam or assignment due date, a holiday, or a link to additional information,

Week 1

- Monday, January 8:
  - Course structure (Syllabus);
  - Handouts;
  - Canvas web page;
  - My web page for the course
  - Number systems (bases): Decimal, binary, hexadecimal alphabets; positional representation of natural numbers; logarithmic relationship between value and string length
- Wednesday, January 10:
  - Naturals in decimal, binary, hexadecimal and other bases
  - Number of symbols to write a natural $n > 0$ in base $b > 1$: $\lfloor \log_b n \rfloor + 1$
  - Range $[0, (b^k - 1)]$ and cardinality $|\mathbb{Z}_k|$ of naturals using k numerals in base b
  - Horner's rule for base b to base 10 (decimal) conversion
- Friday, January 12:
  - Horner's rule for base b to base 10 (decimal) conversion
  - Repeated remaindering (reversing Horner's rule) for base 10 to base b conversion
  - Binary $\leftrightarrow$ Octal $\leftrightarrow$ Hexadecimal
  - Ten's complement

Week 2

- Monday, January 15: Martin Luther King Jr. Holiday
- Wednesday, January 17:
  - Ten's complement:
    - Assume a machine with k digit words
    - $(n)_{10c} + (-n)_{10c} = 10^k$
    - Ten's complement numbers $(n)_{10c}$ starting with 0, 1, 2, 3 or 4 are positive and have there normal values: $n = (n)_{10c}$, e.g., $(473)_{10c} = 473$.



Calendar of meaningful dates

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

    * Ten's complement numbers $(n)_{10c}$ starting with 5, 6, 7, 8 or 9 represent negative values: $n = (n)_{10c} - 10^k$, e.g., $-263 = (737)_{10c} - 1000$.
    * Potential problem: Sum of two positive can be negative, e.g., $(37 + 43)_{10c} = (80)_{10c} = -20$
    * Potential problem: Sum of two negative can be positive, e.g., $(53 + 63)_{10c} = (16)_{10c} = 16$
  - Two's complement:
    * Assume a machine with k bit words
    * $(n)_{2c} + (-n)_{2c} = 2^k$
    * Two's complement numbers $(n)_{2c}$ starting with 0 are positive and have there normal values: $(n)_2 = (n)_{2c}$, e.g., $(0110)_{2c} = (110)_2 = 6$.
    * Two's complement numbers $(n)_{2c}$ starting with 1 represent negative values: $(n)_2 = (n)_{2c} - 2^k$, e.g., $(1110)_{2c} = (1110)_2 - 2^4 = -2$.
    * Bit flipping rule to negate an integer: Copy bits from right-to-left up-to and including first 1 Flip the remaining bits to the left.
- Friday, January 19:
  - Convert decimal to two's complement
  - Pad k bit two's complement numbers to more bits.
  - Fixed-point numbers:

$$\mathbb{F} = \{(x.y)_b : \text{where } x \text{ and } y \text{ base } b \text{ are strings.}\}$$

  - Evaluate to decimal using Horner's rule and division by power of b.

$$(x.y)_b = \text{horner}_b(xy)/b^{|y|}$$

  E.g., $3.14 = 314/10^2$, $(1100.1010)_2 = (11001010)_2 / 2^4$
  - Converting rational numbers to binary
  - Floating point numbers:
    * Decimal scientific notation: $x \times 10^n$, $x \in \mathbb{Q}$, $n \in \mathbb{Z}$.
    * Normalized decimal: $x = d.y$ where $d \in \{1, 2, \ldots, 9\}$.
    * Binary scientific notation: $(x)_2 \times 2^n$, $x \in \mathbb{F}$, $n \in \mathbb{Z}$.
    * Normalized binary: $x = 1.y$
    * Exponent n written in biased notation: $(n)_{\text{bias}=b} = n - b$.
    * Eight bit format for normalized binary floating point number x

s	e_2	e_1	e_0	f_{-1}	f_{-2}	f_{-3}	f_{-4}

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

Value

$$x = (-1)^s \left(1.f_{-1}f_{-1}f_{-1}f_{-4}\right)_2 \times 2^{(e_2e_1e_0)_{\text{bias}=3}}$$

Pidgin set of floating point numbers

$$\mathbb{FP} = \left\{\pm \left(1.wxyz\right)_2 \times 2^{efg_{\text{bias}=3}}\right\}$$

* IEEE 754 Standard for Floating Point Arithmetic

Week 3

- Monday, January 22:
  - Floating point numbers examples:

$$\begin{aligned}(11111111)_{fp} &= \quad -31/16 \times 2^4 = -31\\ (00001000)_{fp} &= \quad +3/2 \times 2^{-3} = +3/16\end{aligned}$$

  - Boolean Logic: Not, And, Or, Implication
- Wednesday, January 24:
  - Truth tables for Equivalence, Exclusive-Or
  - Half and full adders
  - Rules of Inference
    * Modus Ponens $(\textsc{p} \wedge (\textsc{p} \Rightarrow \textsc{q})) \Rightarrow \textsc{q}$

      "You have a valid password" and "If you have a valid password, then you can log on to the network" Therefore, "you can log on to the network"
    * Currying $((\textsc{p} \wedge \textsc{q}) \Rightarrow \textsc{r}) \equiv (\textsc{p} \Rightarrow (\textsc{q} \Rightarrow \textsc{r}))$
- Friday, January 26:
  - Rules of Inference
    * De Morgan's Laws

$$\neg(\textsc{p} \vee \textsc{q}) \equiv \neg\textsc{p} \wedge \neg\textsc{q} \quad \text{and} \quad \neg(\textsc{p} \wedge \textsc{q}) \equiv \neg\textsc{p} \vee \neg\textsc{q}$$

    * Modus Tollens $(\neg q \wedge (\textsc{p} \Rightarrow \textsc{q})) \Rightarrow \neg\textsc{p}$
    * Reductio ad Absurdum $((\textsc{p} \Rightarrow \textsc{q}) \wedge (\textsc{p} \Rightarrow \neg\textsc{q})) \Rightarrow \neg\textsc{p}$
-
  - Monday, January 29: In class quiz #1
- Wednesday, January 31:
  - Sets: $\mathbb{B}$, $\mathbb{D}$, $\mathbb{H}$, $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{Q}$, $\mathbb{R}$, $\mathbb{Z}_m$,
  - Set Operations: Set Complement $\neg\mathbb{X}$, Intersection $\mathbb{X} \cap \mathbb{Y}$, Union $\mathbb{X} \cup \mathbb{Y}$
  - Empty set $\emptyset$ and Universal set $\mathbb{U}$
  - Venn and Euler diagrams

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

- Disjoint sets and partitions of a set
- Subset of a set: $\mathbb{X} \subseteq \mathbb{Y}$ if (and only if) every element z in $\mathbb{X}$ is also in $\mathbb{Y}$.

- Friday, February 2:
  - Counting regions in a universe partitioned by intersecting sets – there are 2^{2^n}
  - Counting Boolean expressions – there are 2^{2^n}
  - There are more 9 variable Boolean expressions (region colorings) than hydrogen atoms in the universe.

Week 4

- Monday, February 5:
  - First Order (Predicate) Logic
  - Quantification over sets: For all $\forall$; There exists $\exists$
- Wednesday, February 7:
  - De Morgan like laws for quantified predicates

$$(\neg(\forall x)(P(x))) \equiv (\exists x)(\neg P(x))$$

$$(\neg(\exists x)(P(x))) \equiv (\forall x)(\neg P(x))$$

  - For all $\forall$ and $\exists$ do not (usually) commute.
- Friday, February 9:
  - Alice: $\vec{A} = \langle 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, \ldots \rangle$
  - Gauss: $\vec{G} = \langle 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 \ldots \rangle$
  - Triangular: $\vec{T} = \langle 0, 0, 1, 3, 6, 10, 15, 21, 28, 36, 45, \ldots \rangle$
  - Mersenne: $\vec{M} = \langle 0, 1, 3, 7, 15, 31, 63, 127, 255, 511, \ldots \rangle$
  - Fibonacci: $\vec{F} = \langle 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, \ldots \rangle$
  - Harmonic: $\vec{H} = \left\langle 0, 1, \frac{3}{2}, \frac{11}{6}, \frac{25}{12}, \frac{137}{60}, \ldots \right\rangle$
  - Functions and recursive equations for terms in sequences

Week 5

- Monday, February 12:
  - The sum and difference of sequences (integrals and derivatives of functions)
  - Back of the envelope calculations: When the world ends
  - Induction: Sum of first n natural numbers
  - Induction: Sum of first n powers of two
- Wednesday, February 14: Review
- Friday, February 16: In class quiz #2

Week 6

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

- Monday, February 19: President's Day
- Wednesday, February 21: Induction & Recursion
- Friday, February 23: Recursion: Proving functions satisfy recurrence equations

Week 7

- Monday, February 26:
  - Solving recurrences equations by unrolling
  - Functions
    * Polynomials
    * Logarithms and exponentials
- Wednesday, February 28:
  - Logarithms and exponentials
  - Floors and ceilings
  - The mod function
  - Greatest common divisors
  - Permutations
  - Composition of functions
- Friday, March 2: Midterm Examination

Week 8

- Monday, March 5: Spring Break
- Wednesday, March 7: Spring Break
- Friday, March 9: Spring Break

Week 9

- Monday, March 12:
  - One-to-one functions
  - Onto functions
  - The inverse $f^{-1}(x)$ of a function $f(x)$
  - Pigeonhole principle
- Wednesday, March 14:
  - The Pigeonhole principle
  - Relations
    * Infix notation: $x \sim y$ where $x \in \mathbb{X}$ and $y \in \mathbb{Y}$.
    * For a fixed x there can be one or more y's such that $x \sim y$ (One-to-many)
    * Examples:
      · Partial Orders: Less than or equal $(\leq)$, Subset $(\subseteq)$, Divides $(\backslash)$

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

  - Equivalence: Congruence mod m ($\equiv \bmod m$), parallel lines ($\|$), homogeneous coordinates ($\propto$)
  - Others: Relatively prime ($\perp$), perpendicular (orthogonal) lines (also ($\perp$)), approximately equal ($\approx$)

- Friday, March 16:
  - Reflexive relations: $(\forall a)(a \sim a)$
  - Symmetric relations: $(\forall a, b)(a \sim b \Rightarrow b \sim a)$
  - Antisymmetric relations: $(\forall a, b)((a \sim b \wedge b \sim a) \Rightarrow a = b)$
  - Transitive relations: $(\forall a, b, c)((a \sim b \wedge b \sim c) \Rightarrow (a \sim c))$
  - Partial Orders
    * Properties: Reflexive, Antisymmetric, and Transitive
    * Examples: $\leq$, $\backslash$, $\subseteq$

Week 10

- Monday, March 19:
  - Equivalences
    * Properties: Reflexive, Symmetric, and Transitive
    * Examples: ($\equiv \bmod m$, $p_0 \propto p_1$)
    * Equivalences partition and set and vice versa
- Wednesday, March 21:
  - Adjacency matrix representation of a relation
- Friday, March 23:
  - Counting relations by counting adjacency matrices
    * There are $2^{|\mathbb{Y}||\mathbb{X}|}$ relations $\mathbb{X} \sim \mathbb{Y}$
    * There are $2^{n(n-1)}$ reflexive relations $\mathbb{X} \sim \mathbb{X}$, where $n = |\mathbb{X}|$.
    * There are $\sqrt{2^{n(n+1)}}$ symmetric relations $\mathbb{X} \sim \mathbb{X}$, where $n = |\mathbb{X}|$.

Week 11

- Monday, March 26:
  - Adjacency matrix representation of a function
  - Using a functions adjacency matrix to test onto and one-to-one
    * Onto: Every column has at least one 1
    * One-to-one: No column has more than 1
  - Counting functions: There are $|\mathbb{Y}|^{|\mathbb{X}|}$ functions $f : \mathbb{X} \mapsto \mathbb{Y}$
  - Recall the count of Boolean functions: 2^{2^n}.
  - Binomial coefficients: Factorial form

$$\binom{n}{k} = \frac{n!}{k!(n-k!}$$

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

- Pascal's Identity and Absorption Identity

$$\binom{n}{k} = \binom{n-1}{k} + \binom{n-}{k-1} \quad \text{and} \quad \frac{n}{k}\binom{n-1}{k-1}$$

- There are 2^n subsets of an n element set $\mathbb{X}$.
- Binomial coefficient $\binom{n}{k}$ counts the number of k-element subsets of an n-element set
- Binomial theorem

$$(x+y)^k = \sum_{k=0}^{n} \binom{n}{k} x^{n-k} y^k$$

- Wednesday, March 28:
  - Binomial coefficient: Absorption rule $\binom{n}{k} = \frac{n}{k}\binom{n-1}{k-1}$
  - Stirling's identity of the second kind

$$\left\{ {n \atop k} \right\} = k \left\{ {n-1 \atop k} \right\} + \left\{ {n-1 \atop k-1} \right\}$$

    counts the number of partitions of a set (equivalences)

- Friday, March 30: In class quiz #3

Week 12

- Monday, April 2:
  - Permutation written in cyclic and matrix form
  - Stirling's identity of the first kind

$$\left[{n \atop k} \right] = (n-1) \left[{n-1 \atop k} \right] + \left[{n-1 \atop k-1} \right]$$

    counts the number of permutations by cycles
  -
- Wednesday, April 4:
  - Pseudo-random sequence: $x_n = (ax_{n-1} + b) \bmod m$.
  - Caesar cipher: Encode n: $m = (n+k) \bmod 26$; Decode m: $n = (m-k) \bmod 26$
  - Affine cipher: Encode n: $m = (an+k) \bmod 26$; Decode solve $m = (an+k) \bmod 26$ for m.
  - Modular numbers
    * Poor man's random number generator: $x_k = (ax_{k-1} + b) \bmod m$, $a, b \in \mathbb{Z}$, $m \in \mathbb{N}^+$, x_0 a "seed."
    * Cryptography
      · Caesar cipher: Encode: $y = (n+k) \bmod 26$, Decode $x = (n-k) \bmod 26$

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

- Affine cipher: Encode: $y = (ax + b) \bmod m$, Decode $x = a^{-1}(y - b) \bmod m$
- Modular arithmetic: $(a \pm b) \bmod m = (a \bmod m) \pm (b \bmod m)$
- Additive inverses: $(a + b = km) \Rightarrow (-a = b)$
- Modular multiplication: $(ab) \bmod m = (a \bmod m)(b \bmod m)$
- Multiplicative inverses: $(ab = km + 1) \Rightarrow (a^{-1} = b)$
- Brute-force search for a^{-1}

- Friday, April 6:
  - Goal: Given $a \bmod m$, compute $a^{-1} \bmod m$.
  - Euclidean algorithm to compute $gcd(a, m)$: $a = mq + r$; $a \hookleftarrow m$ and $m \hookleftarrow r$; repeat until $r = 0$.
  - Bézout's identity: $(\exists b, c \in \mathbb{Z})(ab + mc = \gcd(a, m))$
  - If $\gcd(a, m) = 1$ and $ab + mc = 1$, then $a^{-1} = b$.
  - 2×2 matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ and its determinate $ad - bc$.
  - 2×2 identity matrix $\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$

Week 13

- Monday, April 9:
  - Given $ax = b \bmod m$ where $\gcd(a, m) = 1$. construct "magic table" to compute u and v such that $au + mv = 1$
  - Conclude that $a^{-1} = u \bmod m$
  - And, $x = bu \bmod m$ solves $ax = b \bmod m$ when $\gcd(a, m) = 1$.
- Wednesday, April 11:
  - Axioms (Postulates): Statements that are "accepted as `True`"
    - First-order (Predicate) Logical Axioms (Boolean tautology, equality, name substitution, universal instantiation $(\forall x)(\mathrm{P}(x)) \Rightarrow (\exists t)(\mathrm{P}(t))$, existential generalization $\mathrm{P}(t) \Rightarrow (\exists x)(\mathrm{P}(x))$
    - Boolean algebra axioms for propositions and sets: (operations, closure, commutative, associative, distributive, identity, inverses)
    - Peano axioms for arithmetic: (zero, equality, successor function (is one-to-one), zero is not a successor, induction
  - Rules of inference
    - Completeness $(\mathrm{P} \Rightarrow \mathrm{Q}) \vee (\mathrm{P} \Rightarrow \neg\mathrm{Q})$
    - Modus Ponens $(\mathrm{P} \wedge (\mathrm{P} \Rightarrow \mathrm{Q})) \Rightarrow \mathrm{Q}$

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

- Modus Tollens (Soundness) $(\neg Q \wedge (P \Rightarrow Q)) \Rightarrow \neg P$
- Reductio ad Absurdum ((In)Consistency) $((P \Rightarrow Q) \wedge (P \Rightarrow \neg Q)) \Rightarrow \neg P$
- To Curry $((P \wedge Q) \Rightarrow R) \Rightarrow (P \Rightarrow (Q \Rightarrow R))$
- To UnCurry $(P \Rightarrow (Q \Rightarrow R)) \Rightarrow ((P \wedge Q) \Rightarrow R)$

- Friday, April 13:
  - Direct proofs (modus ponens)
    - Pythagorean theorem: $(a+b)^2 = a^2 + b^2 + 2ab = 4(\frac{1}{2}ab) + c^2$ (see diagram)
    - If n is odd, then n^2 is odd
    - Divides is transitive
  - Indirect proofs (modus tollens)
    - If $n > 0$ and $4^n 1$ is prime, then n is odd: $P = n$is even and $Q = 4^n - 1$is not prime. Then $P \Rightarrow Q$ and $\neg Q$ imply n is odd.
    - If $n + m$ is even then n and m have the same parity
    - If n is a positive integer such that $n \mod 4$ is 2 or 3, then n is not a perfect square.
  - Proofs by counterexample (to show a statement is invalid)
    - Give example to show $(a \equiv b \bmod m) \Rightarrow (a = b)$ is `False`
    - Give example to show $(ab \in \mathbb{Q}) \Rightarrow (a, b \in \mathbb{Q})$ is `False`
    - Divides is symmetric is `False`
    - $\sum_{k=0}^{n-1} k^2 = \binom{n}{3}$ is `False`

Week 14

- Monday, April 16:
  - Proofs by contradiction (reductio ad absurdum)
    - The primes are not finite
    - $\sqrt{2} \notin \mathbb{Q}$
  - Cantor's diagonalization argument that the reals are uncountable
- Wednesday, April 18:
  - The Liar's paradox: "This statement is a lie." If it `True`, then it is a lie, and if it is `False`, then it is `True`.
  - In Seville, the barber shaves all those, and only those, who do not shave themselves. Who shaves the barber?
  - Russell's paradox: Let $\mathbb{S} = \{\mathbb{X} : \mathbb{X} \notin \mathbb{X}\}$ be the set of all sets that do not contain themselves. Is $\mathbb{S} \in \mathbb{S}$. This gave rise to the theory of *types*, essential in computing.
- Friday, April 20: In class quiz #4

January

~~1~~	~~2~~	~~3~~	~~4~~	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

	1	2	3	4	5	6

Week 15

- Monday, April 23: Course review
- Wednesday, April 25: Course review
- Friday, April 27: Study Day

Week 16

- Thursday, May 3: Final Examination, Evans Library P-133, 1:00 p.m. to 3:00 p.m.