1/21/2026 Patterns in (environmental) math Class Notes

Today: Some interesting numbers ; the number system:

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1. **Please read all the information on update page and course page.**
2. **Quiz 1 on Friday 1/23. Details soon on update page.**
3. **QUIZZES ARE 30% OF GRADE. IF YOU PAY ATTENTION, EASY TO GET RIGHT ANSWER.**
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Number systems

Decimal systems (Indo-Arabian) -- base 10

Vigesimal systems (Mayans, Africa,..) – base 20

Sexagesimal system (Babylon) – base 60

Base 2 – used in computers – binary system

Hexadecimal system (used in computers) – base 16

Example:

21 = 20+1 = 2x10^1+1 in decimal system

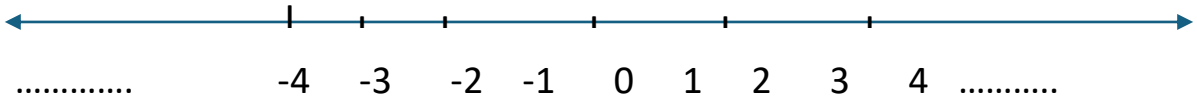
21 = 16+4+1 = 2^4+2^2+1 = 10101 in base 2 (binary) system

Exercise: Write 100 in base 2

100 = 64 + 32 +4 = 2^6 + 2^5 + 2^2 = 1100100

All real numbers can be represented on the line.

Set of real numbers = $\mathbb{R}$.



$\mathbb{N}$ = set of natural numbers = 1,2,3,4,…. and so on.

$\mathbb{Z}$ = set of integers = …..$-4, -3, -2, 0, 1, 2, 3, \ldots$.. = Set of natural numbers and their negatives along with zero.

These are marked on the line above. In between these integers are the rational and irrational numbers. For example, 1.5 is between 1 and 2.

$\mathbb{Q}$ = Set of rational numbers = Set of numbers that are fractions of an integer by a non-zero integer = Set of all numbers represented by terminating or repeating decimal expansions.

Example: 1.5 = 3/2 , 1/3 = 0.33333….

Then there is the set of irrational numbers which are numbers such as $\sqrt{2}$, π etc., As we saw in class, $\sqrt{2}$ is between 1 and 2 (because its square is between 1 and 4). It is approximately equal to 1.414…

Similarly all real numbers, including irrationals can be approximated by decimals but the actual decimal expansion of irrationals is non-terminating, non-repeating. There are many, many more irrationals than rationals!

$\pi = 3.14159\ldots$. can be approximated as $\frac{22}{7}$ and by 3.14.

$\sqrt{2}$ = 1.414…. can be approximated by 1.41.

Fibonacci sequence: 1,1,2,3,5,8,13,21,… occurs frequently in nature

Golden ratio also appears in nature and architecture: (1+Sqrt(5))/2.

Practice problem:

Write 861 in base 2 and base 20.

Base 2: 861 = 512+ 256 + 64 + 16+ 8 + 4 + 1 =
2^9+2^8+2^6+2^4+2^3+2^2+2^0 = 1101011101

Base 20: Each digit can be anything from 0 to 19.

861 = 2(400) + 3(20) + 1 = 231 in base 20.

More practice:

1. Write 757 in base 2 and base 20. Show step by step solution!

   757 = 512+128+64+32+16+4=1 = 1011110101 in base 2

   757 = 400 + (17)x 20 + 17 in base 20 = 1QQ where Q represents 17.

2. Watch video on “Pi and Fibonacci sequence” and write down 3 situations in nature or in real life where Pi and the Fibonacci numbers show up.