ENR145 Computational Methods:
Mid-term review

Xiang Li

Spring 2026

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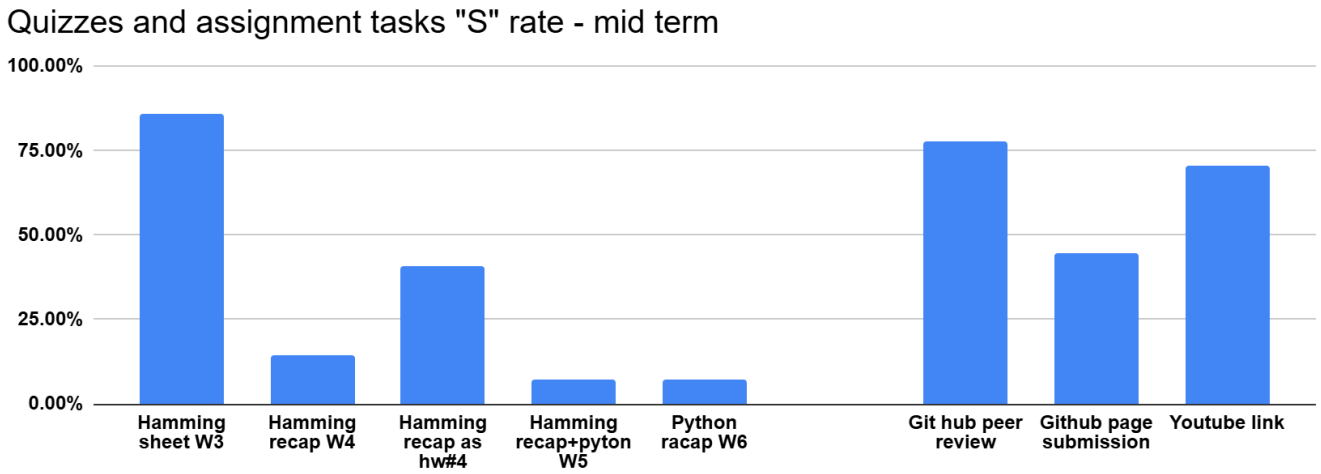
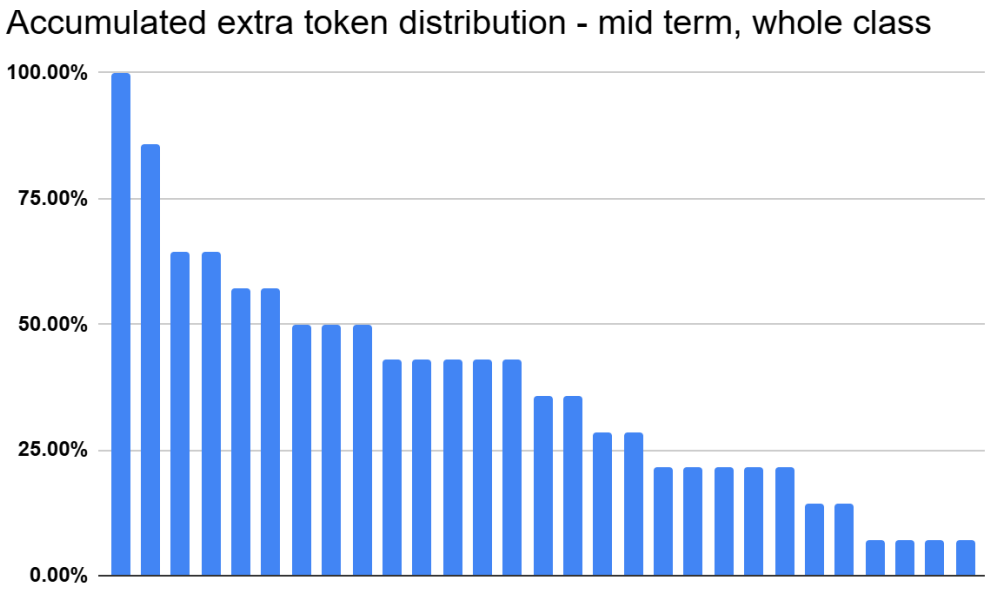
ENR 145 has coding issues?





From numbers, math to codes:

- Decreased “S” completion of subject matter.

- Accumulated token bump and toolbox bump won’t generate enough A grade (to my taste).

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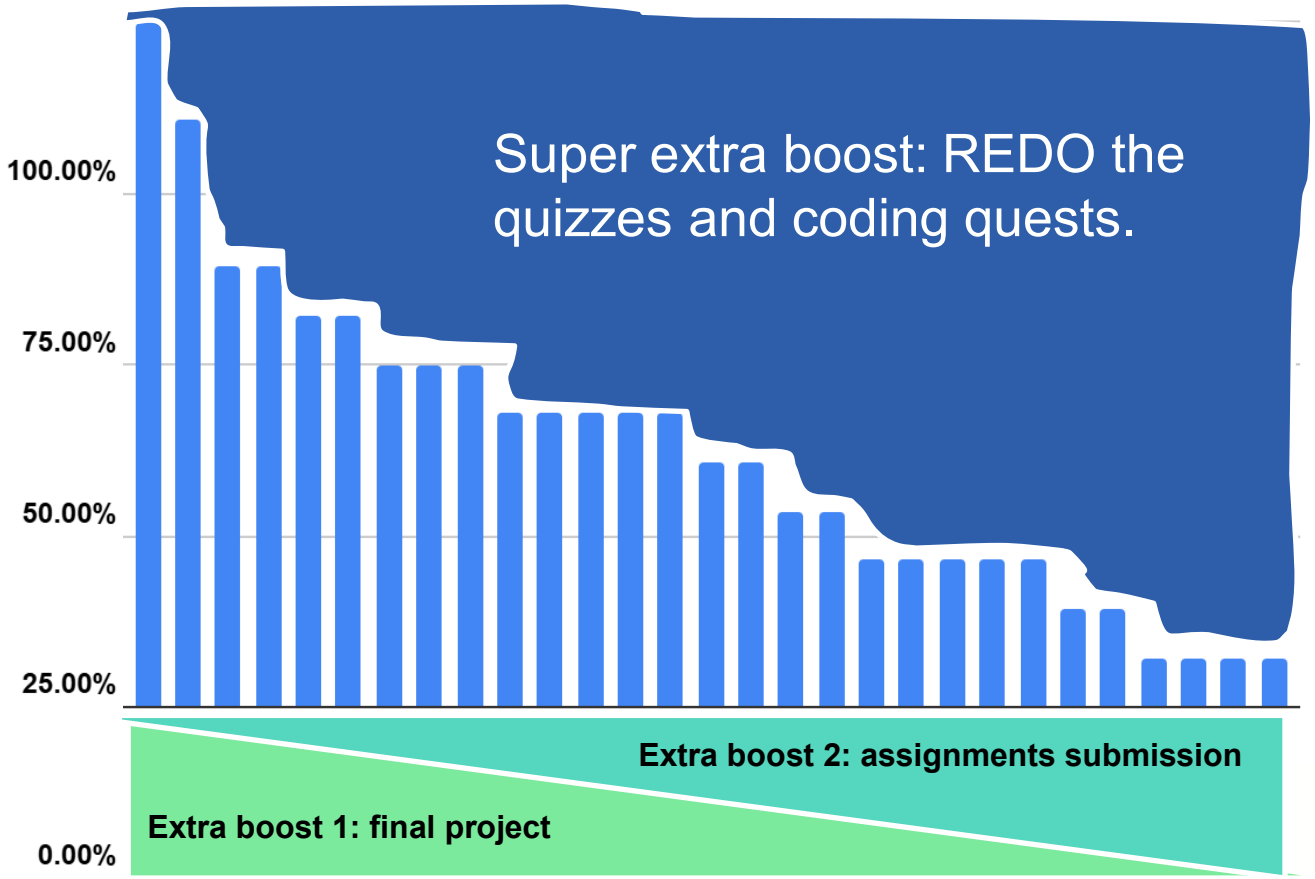
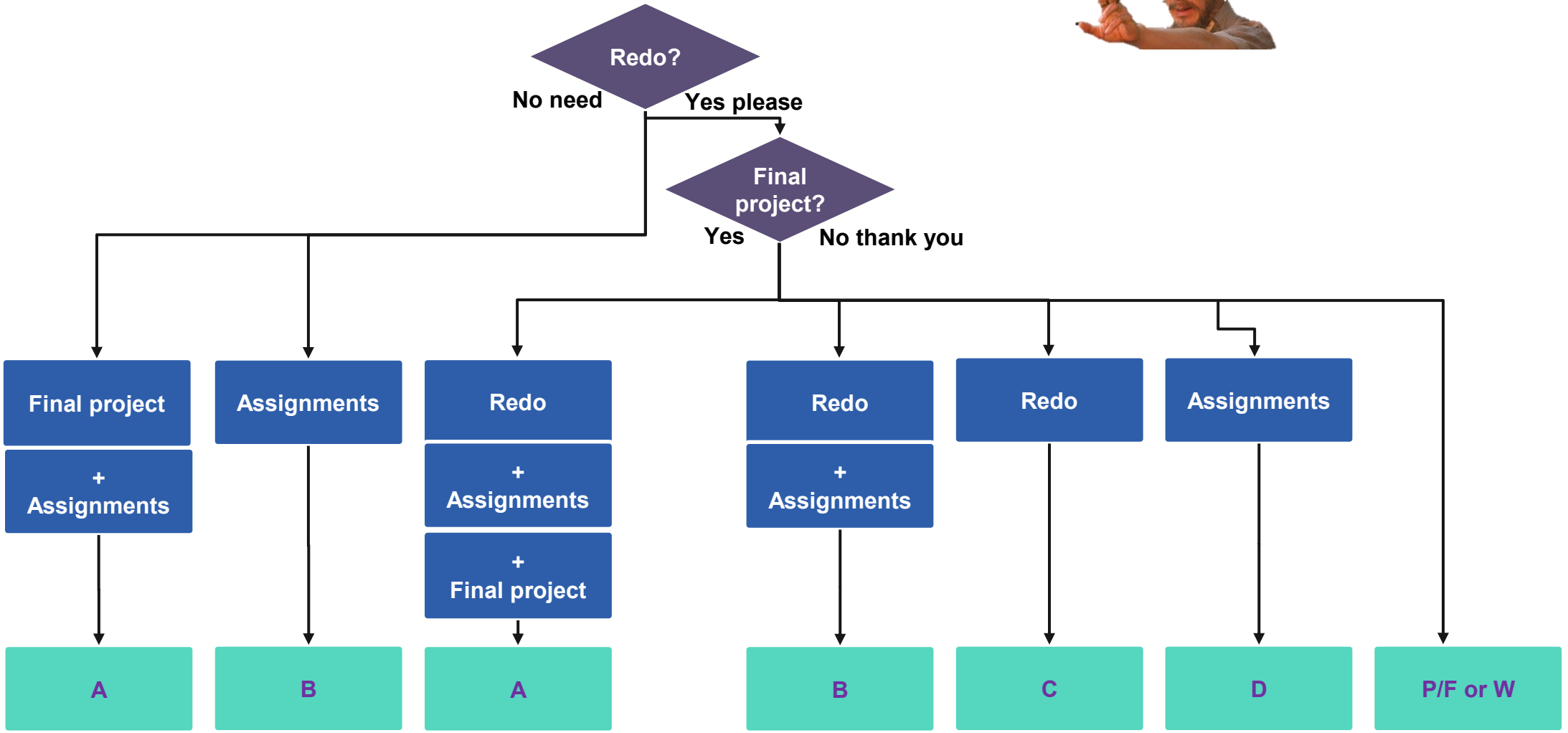
Guys we can fix this:

- *Easy assignments from now on.
- Chance to redo the quizzes and coding tasks.
- Final project optional.



*Easy as no “skill checks” in quizzes. But submission deadline rules still apply.

Possible outcome?



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When redo?

1. Individual appointment
2. Bit sized task sessions (Hamming math, Hamming python, Hamming numpy… etc)
3. The tasks won't be the same as the old quizzes, it's a "skill check".

And finally: class room engagement issue: we need to talk about the cellphone use.

We will still have a quiz this week about numpy and “hamming numpy”

$$M3 = M1 \times M2 = \begin{bmatrix} a_1 & b_1 \\ c_1 & d_1 \end{bmatrix} \times \begin{bmatrix} a_2 & b_2 \\ c_2 & d_2 \end{bmatrix} = \begin{bmatrix} a_1 \times a_2 + b_1 \times c_2 & a_1 \times b_2 + b_1 \times d_2 \\ c_1 \times a_2 + d_1 \times c_2 & c_1 \times b_2 + d_1 \times d_2 \end{bmatrix}$$

So, a [2,3] x [3,4] = [2,4]

```python
I_1 = np.eye(11, dtype=int) # we define data tyep to int so we save some storage (default number type in numpy is over-kill for this application)
## TODO: encoding P1-P4, and P0 based on our theory, our SoS matrix:
# P1 checks: D1, D2, D4, D5, D7, D9, D11
# P2 checks: D1, D3, D4, D6, D7, D10, D11
# P3 checks: D2, D3, D4, D8, D9, D10, D11
# P4 checks: D5, D6, D7, D8, D9, D10, D11
P_1 = np.array([
  # P1 P2 P3 P4
    [1, 1, 0, 0],  #D1
    [1, 0, 1, 0],  #D2
    [0, 1, 1, 0],  #D3
    [1, 1, 1, 0],  #D4
    [1, 0, 0, 1],  #D5
    [0, 1, 0, 1],  #D6
    [1, 1, 0, 1],  #D7
    [0, 0, 1, 1],  #D8
    [1, 0, 1, 1],  #D9
    [0, 1, 1, 1],  #D10
    [1, 1, 1, 1],  #D11
])
G_1 = np.concatenate((I_1, P_1), axis=1)  # this is just a simple function to stich two matrix together
# print (G_1)
```

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We will still have a quiz this week about numpy and hamming numpy 

```
#3.2 now let's do a [15,16] "G_2 matrix" (I2|P0)
I_2 = np.eye(15, dtype=int)
# print (I_2)
P_0 = np.ones((15, 1), dtype=int) # total parity check P0 is going to Sum all the bits (d1-d11, P1-P4)
G_2 = np.concatenate((I_2, P_0), axis=1)
# print (G_2)

#3.2 the ultimate generator matrix [11,5] X [15,16] = [11,16]
G = G_1 @ G_2 %2
```

```
# this error checking code, is basically your P matrix sitting on top of a (5x5) "eye" matrix

#We just need the "non-eye" part of the generator matrix (why?)
#                      -------------
#                      |This part  |
#[[1 0 0 0 0 0 0 0 0 0 0|1 1 0 0 1] |
# [0 1 0 0 0 0 0 0 0 0 0|1 0 1 0 1] |
# [0 0 1 0 0 0 0 0 0 0 0|0 1 1 0 1] |
# [0 0 0 1 0 0 0 0 0 0 0|1 1 1 0 0] |
# [0 0 0 0 1 0 0 0 0 0 0|1 0 0 1 1] |
# [0 0 0 0 0 1 0 0 0 0 0|0 1 0 1 1] |
# [0 0 0 0 0 0 1 0 0 0 0|1 1 0 1 0] |
# [0 0 0 0 0 0 0 1 0 0 0|0 0 1 1 1] |
# [0 0 0 0 0 0 0 0 1 0 0|1 0 1 1 0] |
# [0 0 0 0 0 0 0 0 0 1 0|0 1 1 1 0] |
# [0 0 0 0 0 0 0 0 0 0 1|1 1 1 1 1]]|
#                      |This part  |
#                      -------------
```

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```
# next we just repeat the hamming coding trick, but on [1,16] output
# output_code: [[1, 0, 1, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1]]
# you can inject 1 bit error below, anywhere:
received_msg = [[1, 0, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1]]
Error_msg = received_msg @ H_T % 2
print ("the error code:")
print (Error_msg)

## TODO: wait, the postion code how?
```

```
the error code:
[[1 0 0 1 1]]
```

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If you can do this, you have the power:

Array to array conversion will be so easy:

This is math:

$$P_{i,j} = \sum_{k=1}^{n} Q_{i,k} \times R_{k,j}$$

This is math application:

[2,3] x [3,4] = [2,4]

This is Engineering application:

11 bits in

16 bits out

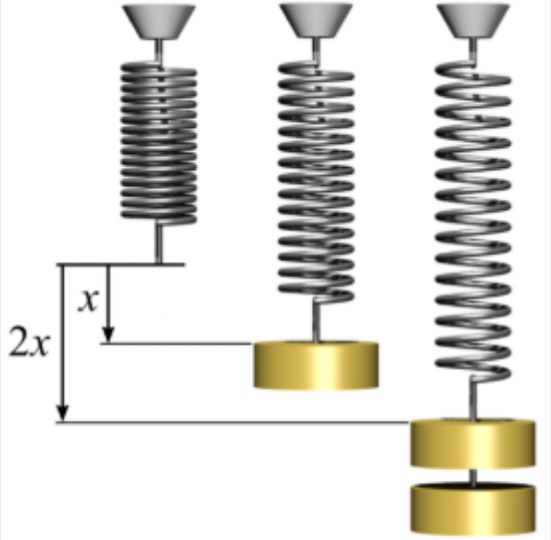
So instead of double for loops, we can do matrix operation to get it in one go?

[1,11] x [?] = [1,16]?

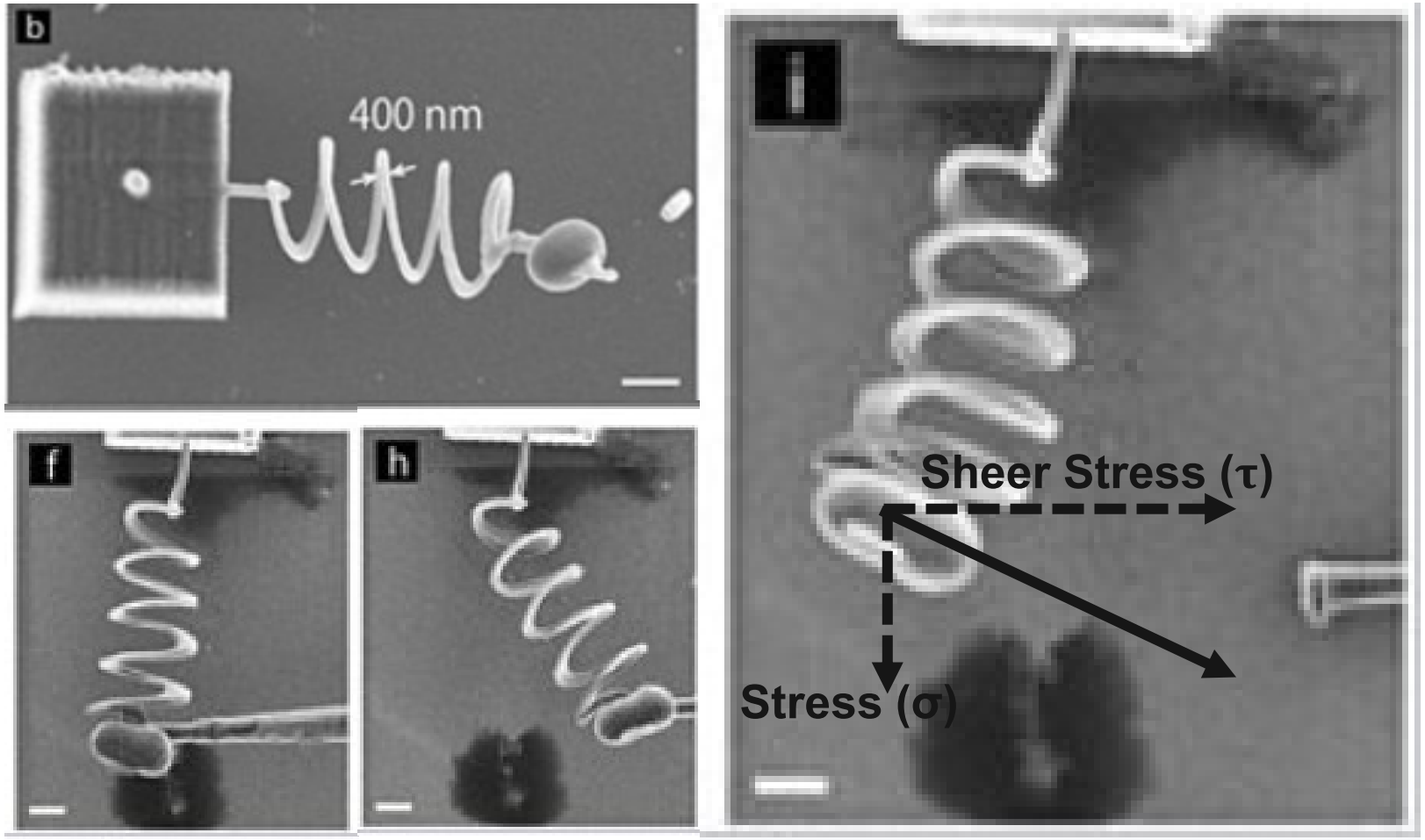
One example to skill check your math power:

Hooke's law

Article Talk



Hooke's law: the force is proportional to the extension $F_s = kx$



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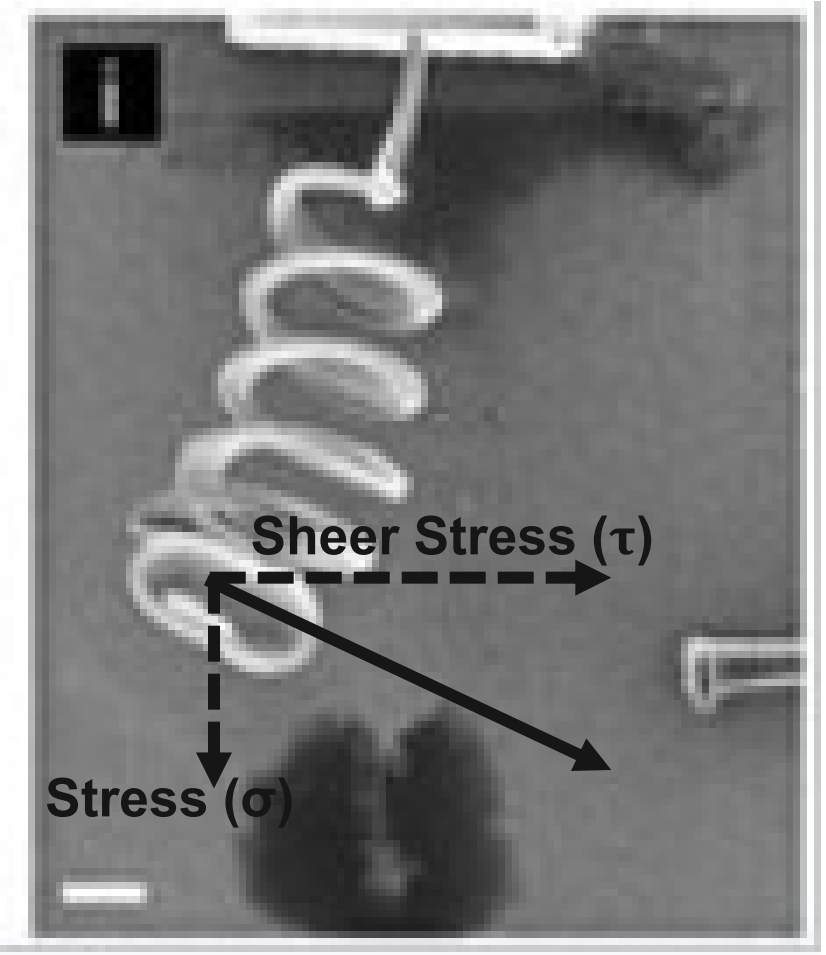
https://en.wikipedia.org/wiki/Hooke%27s_law

Yes, math is power (1/3)



If there's stress (σ), then there's deformation , aka strain (ε)

If 1D, just like $F_s = kx$ We can have σ = Eε, or ε = $\frac{1}{E}$σ

Just like k, E is a constant to deal with force and deformation ratio.

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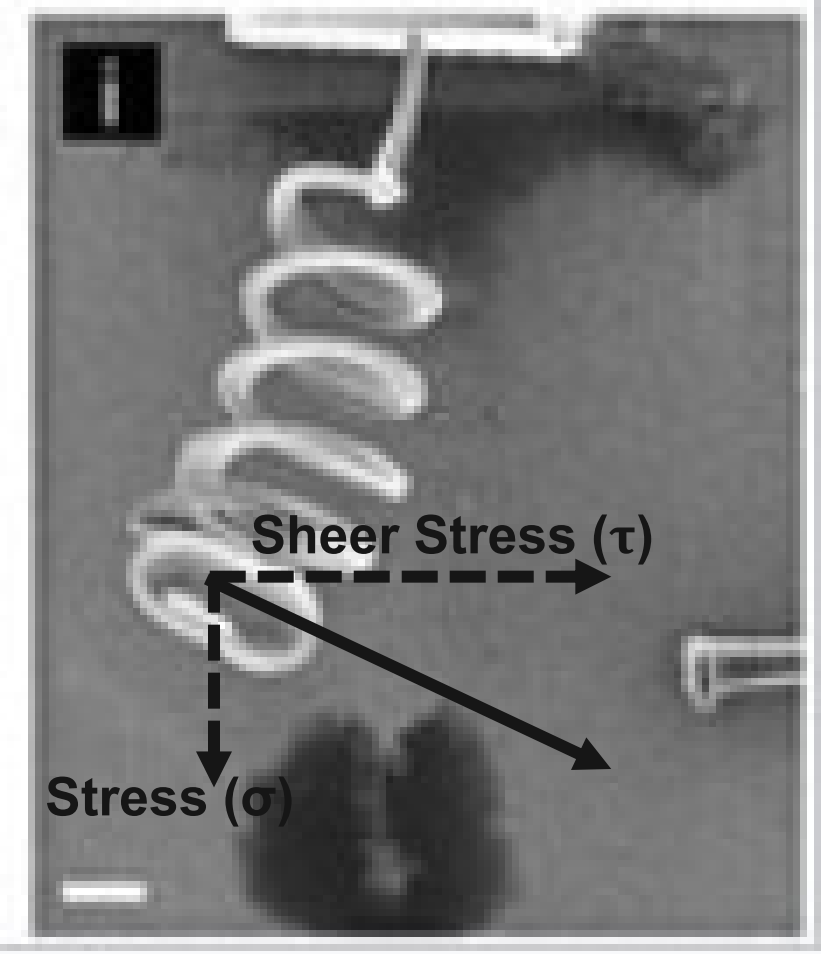
Yes, math is power (2/3)



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If 2D plane:

$$\begin{pmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{xy} \end{pmatrix} = \frac{1}{E} \begin{pmatrix} 1 & -\nu & 0 \\ -\nu & 1 & 0 \\ 0 & 0 & 1+\nu \end{pmatrix} \begin{pmatrix} \sigma_{xx} \\ \sigma_{yy} \\ \sigma_{xy} \end{pmatrix}$$

ν is just another constant to deal with material property.

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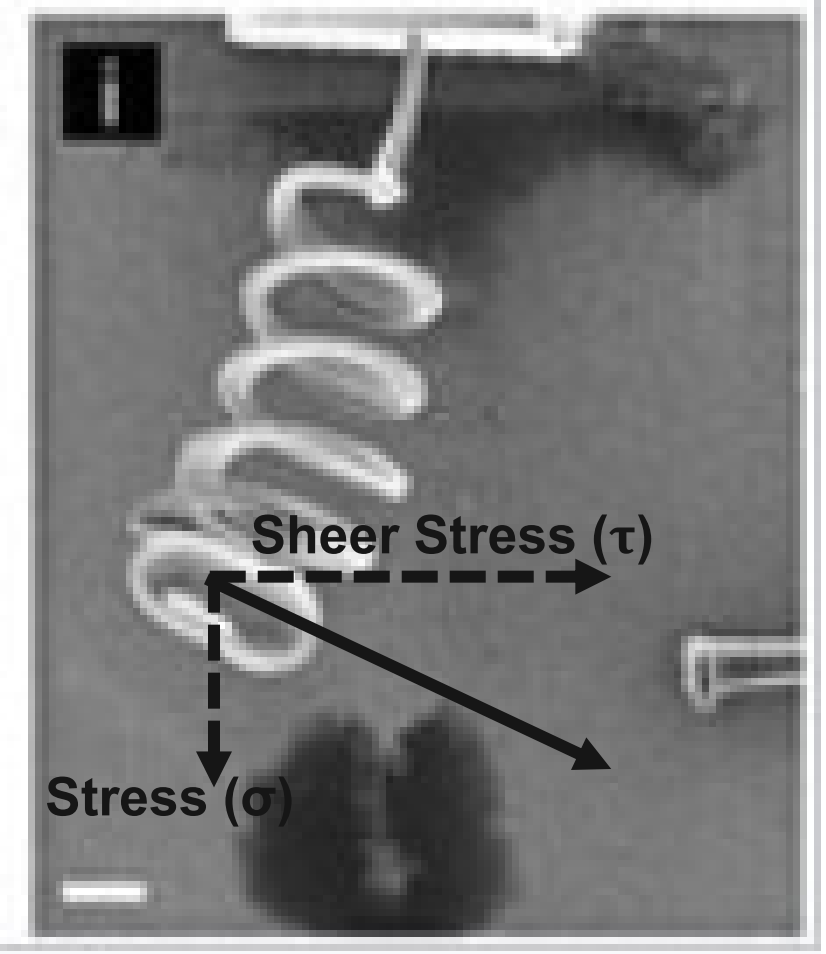
Yes, math is power (3/3)



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ν is just another constant to deal with material property.
What if ν = 0?

With the power of ***matrix multiply***, you can understand mechanical engineering without learning about mechanical engineering.

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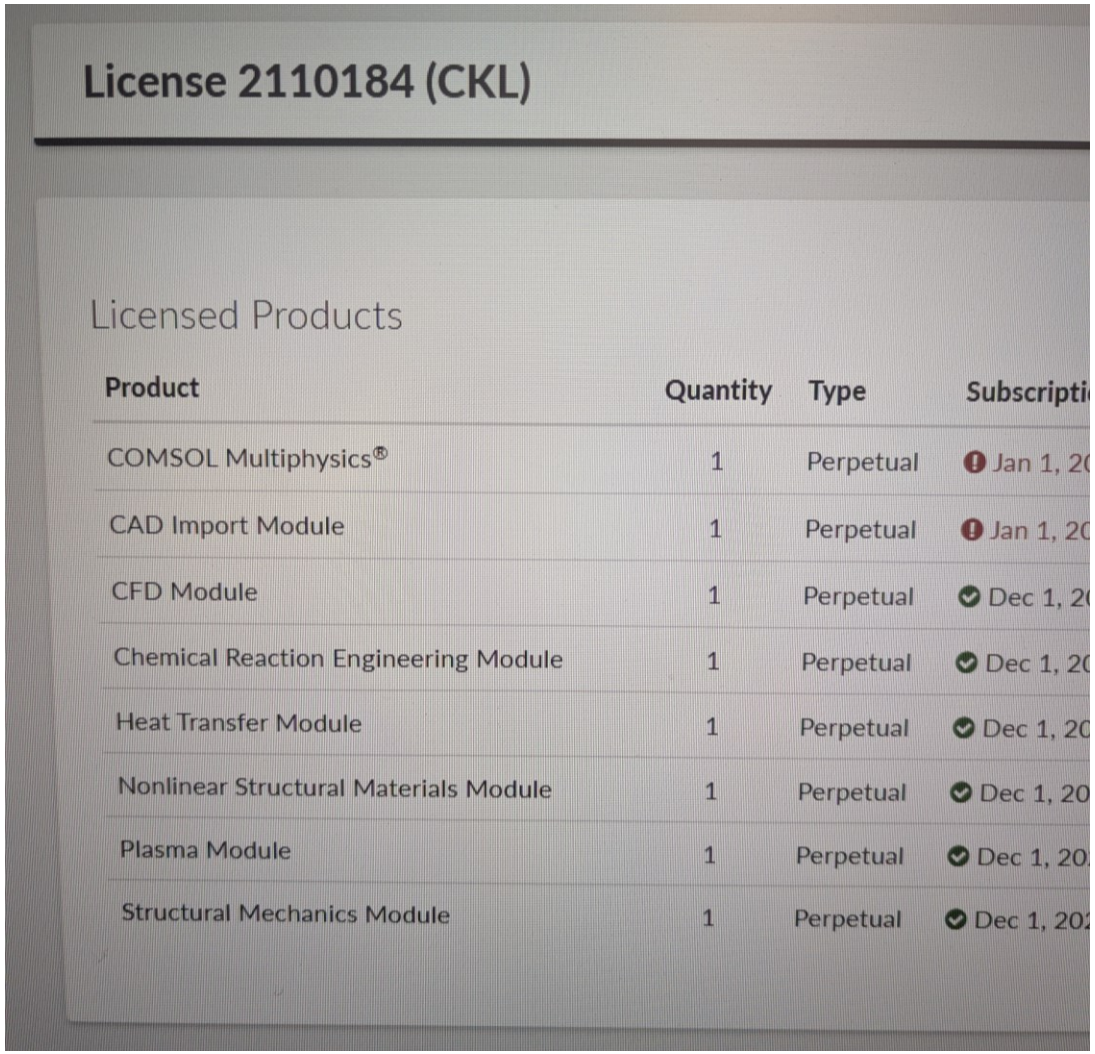
Before we go, I need your help to check the COMSOL on your desktop:



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- **Which PC doesn't have access to the following packages.**
- **Maybe leave the info in ENR 145 channel?**

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