

# Quantum Technician Bootcamp

Brian Rashap

September 2025

# Introduction



# Instructional team

A physicist, an engineer, and a technician walk into a classroom...



# The Engineer: Brian Rashap, Ph.D.

- Proud husband of Krista and father of Shelby (27) and Ethan (23)
- Electrical Engineer (Michigan) with 23 years industrial experience (Intel)
- Created and taught IoT Bootcamp for 5 years (and going)
- Hobbies: painting, cycling, swimming, reading, spending time with family





# The Physicist: Megan Ivory

- Foster mom to two cats, Joey and Tessa; auntie to two humans, Liana and Azeria
- PhD in atomic physics (William and Mary), startup ColdQuanta (now Infleqtion), Univ of Washington, Sandia since 2019 working on atomic clocks, quantum computers, and quantum programs like QuLL!
- Outside hobbies: trail running, hiking, gardening, backpacking, trad climbing, canyoneering, and skiing
- Inside hobbies: cooperative board games, reading trashy fantasy series, acting/writing



I've never taken a quantum information science class. . .



# The Technician: Shawn Morales

- Blessed husband of Joy and proud father of Katelyn (29) and Kimber (28)
- Intel Manufacturing Technician of 32 years
- Worked on 26 different tools within Intel
- Adore my time with family, mountain biking, and the great outdoors





# Student Introductions

- Your name
- What were you up to before starting the bootcamp
- Any prior experience with math, science, machining, etc.
- What do you hope to get out of the bootcamp



# Drinks, Lunch and Snacks

- There is a kitchenette down the hall with coffee/tea, snacks, frig, microwave
  - The rest of the room is the TSL Lab - please don't disturb it
  - Please clean up the area every time you use it.
  - Don't leave leftovers overnight in the frig
- Drink are allowed in the QuLL, but not near the optical tables or vacuum systems
- You can eat lunch in the QuLL,
  - There will be a mid-day 1 hour lunch break
  - Again, no food/drink near optical tables or vacuum systems
  - Tables wiped down at the end of lunch
- No food trash in QuLL garbage can (use the kitchenette trash)



# Class Rules

- Respect each other. Help each other.
- Ask questions.
- Be on time (let us know via Slack if you won't be here)
- Keep your workspace and the classroom neat and tidy.
- If you are struggling, let us know. We are here to HELP!
- Class hours
  - Mon-Th: 8am to 5pm <sup>1</sup> and Friday: 8am to 3pm <sup>2</sup>
  - Lunch Break: 1 hour near noon. Maybe combined with work time.
  - Please respect the instructors' lunch break as well.
- Phone Policy: phones should not be out or used during class
  - No gaming, no surfing social media
  - If you need to take/make a call, please set out of the classroom
  - Exceptions: two-factor authentication, pictures of projects, class videos

<sup>1</sup>Doors open at 7:50, please be in your seats ready to learn by 8:00

<sup>2</sup>Occasionally on Friday there will be optional activities from 3 to 5



# Credit for Prior Learning (CPL)

If students enroll in an academic program at CNM, they are eligible for up to 24 credits through CPL:

- Current CPL (will be finalized before December)
  - MATH 1220 College Algebra
  - BCIS 1110 Fundamentals of Information Literacy and Systems
  - BUSA Business Professionalism
- CPL that can be claimed starting in Fall 2026
  - ENGT 10xx Optics
  - ENGT 20xx Laser and Photonics
  - CSCI 10xx Survey of Quantum Computing
  - CSCI 20xx Quantum Hardware

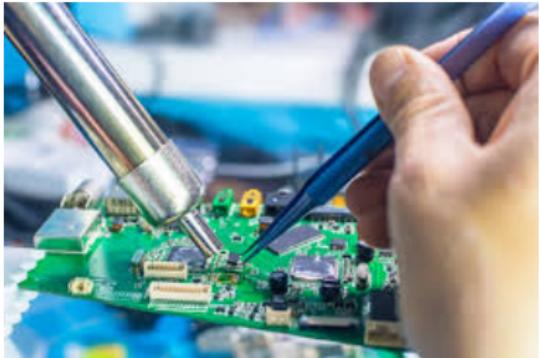


# Foundation of lean Certificate





# IPC Solder Certification

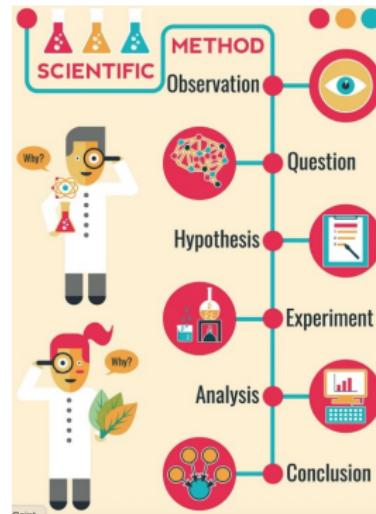


**IPC-J-STD-001 Rev.  
H, Certification**



# Important Attribute in an Employee

- Tolerance of Ambiguity
- Attention to Detail
- Reliability
- Curiosity
- Structured Problem Solving



Note: employers regularly ask the instructional team for references, it is these attributes that we will be the basis of our recommendation.

# Overview: QIS in NM



# Introduction

## NM will be tomorrow's quantum hotbed

The collage includes:

- A screenshot of a news article from "THE QUANTUM INSIDER" titled "Tomorrow's quantum hotbeds? 7 U.S. cities that could incubate the next great quantum technology ecosystem". It features a large image of a city skyline at sunset with a glowing quantum symbol overlaid.
- A photograph of a laboratory or research facility with the text "QUANTUM NEW MEXICO INSTITUTE (QNM-I)" and "RESEARCH".
- A graphic for "Elevate Quantum" with a triangle icon.
- A timeline of events:
  - JANUARY, 2024: "The University of New Mexico launches the Quantum New Mexico Institute"
  - MARCH, 2024: "Governor Polis and Governor Lujan Grisham urge the Department Of Commerce to fund the Regional Quantum Partnership"
  - MAY, 2024: "Central New Mexico Community College" (CNM) receives funding to launch a quantum learning lab and training program.
  - July, 2024: "EDA announces \$504 million in funding to 12 designated tech hubs across America"
- A photograph of a person working at a computer in a lab setting, with the text "National Nuclear Security Laboratories" visible.

**Why?**

- World Class Research Institutions
- Entrepreneurial Ecosystems
- Pro-Innovation Government
- Quantum Solutions for NM priorities



# Introduction

## What is Quantum Information Science (QIS)?

- Emerging technology that will revolutionize computing, communication and sensing:
  - Quantum computers to **solve previously unsolvable problems**
  - Break **unbreakable** cryptography and enable **provably** secure communications
  - Dramatically improve **sensing** and **detection**

The convergence two of the great scientific pillars of the 20<sup>th</sup> Century

**Quantum Mechanics:**  
The physics of the microscopic world

atom      electron      photon

Albert Einstein

**Information Science:**  
Computers & communications

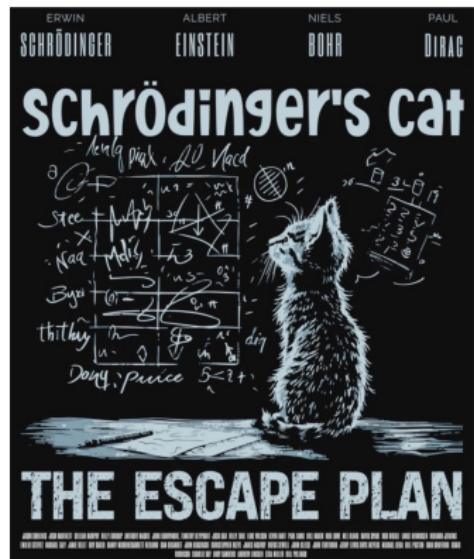
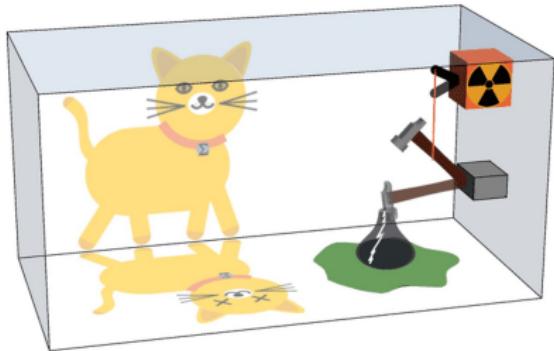
Claude Shannon



# Introduction

## Superposition

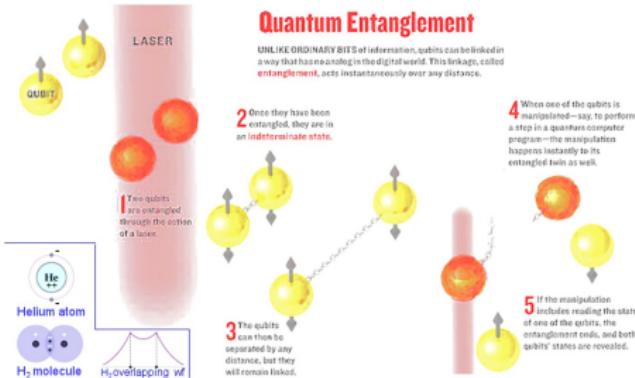
- Superposition describes a particle's ability to exist across many possible states at the same time.
- The superposition collapses into one specific state when a measurement/observation is made.





# Introduction

## Spooky Action at a Distance (Entanglement)



In 1964 John Bell discovered that quantum theory conflicts with any local theories involving hidden variables. He found a way to test whether local hidden variables could account for the apparent "spooky action."



The **Bell test**: Two observers would make separate measurements of two supposedly entangled particles. Bell calculated the maximum amount of correlation that could arise between the two observers' findings if local hidden variables limited by the speed of light were at work.



For the first time, a loophole-free Bell test



At Delft, scientists ran 245 trials in which a pair of electrons 1,280 meters apart were entangled. They measured the particles in every case and found 80 percent were correlated—significantly more than would be possible with local hidden variables.

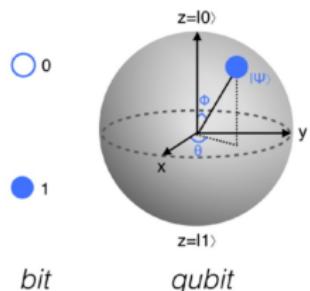
Experiments in the U.S., Austria and Germany found similar results.





# Introduction

## Classical vs Quantum Logic



Input	Output
A	F
0	1
1	0

Inputs		Output
A	B	F
0	0	0
1	0	0
0	1	0
1	1	1

Inputs		Output
A	B	F
0	0	0
1	0	1
0	1	1
1	1	1

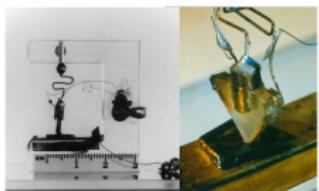
Operator	Gate(s)	Matrix
Pauli-X (X)		$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
Pauli-Y (Y)		$\begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$
Pauli-Z (Z)		$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
Hadamard (H)		$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
Phase (S, P)		$\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$
$\pi/8$ (T)		$\begin{bmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{bmatrix}$
Controlled Not (CNOT, CX)		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$
Controlled Z (CZ)		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$
SWAP		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
Toffoli (CCNOT, CCX, TOFF)		$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$



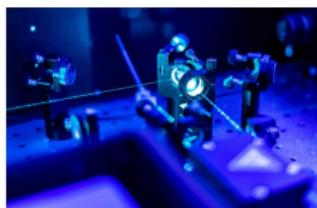
# Introduction

## Quantum Has Been With Us

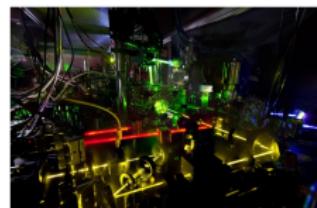
### Transistors / Semiconductors



### Lasers



### Atomic Clocks / GPS



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# Introduction

## Advances in Quantum (Quantum 2.0) will supercharge the information economy

### Quantum Computing

A new computing paradigm that will help us solve problems in completely new ways



BREAK SECRET CODES OR CRYPTOGRAPHY

DRUG DESIGN

OPTIMIZE THE ENERGY GRID

FRAUD DETECTION IN FINANCIAL MARKETS

### Quantum Sensing

Atomic level sensors that will greatly enhance sensing capabilities



GPS DENIED NAVIGATION

ENHANCED BIOLOGICAL SENSORS

MINERAL AND OIL EXPLORATION

### Quantum Communication

Provable secure communication and new communication protocols



THE QUANTUM INTERNET

ULTRA-SECURE COMMUNICATIONS

ENERGY EFFICIENT COMMUNICATIONS

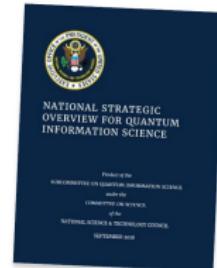


# Introduction

**Quantum is one of the top emerging technologies in the world**

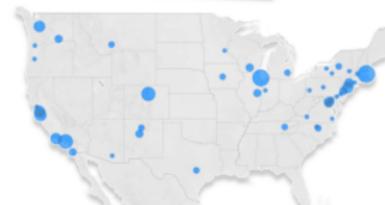
## Federal legislation

- **National Quantum Initiative (NQI):** Passed in 2018, authorized \$1.15B in funding to support an all of government approach to sustain national and economic security in quantum.
- **National Defense Authorization Act (NDAA):** Passed in 2019 and 2020, legislate DOD to carry out and support quantum R&D
- **CHIPS and Science Act:** Passed in 2021, authorized additional funding for quantum infrastructure, R&D, and workforce development programs



## Federally supported quantum programs

- **National Science Foundation**
  - Quantum-Leap Challenge Institutes\*
  - Technology, Innovation and Partnerships
- **Department of Energy**
  - NQI Science and Research Centers\*
  - Office of Science - Reaching a New Energy Sciences Workforce
- **Department of Defense**
  - NDAA QIS Research Centers\*
  - Defense Advanced Research Projects Agency
  - Office of the Undersecretary of Defense for Research and Engineering

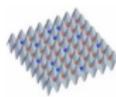
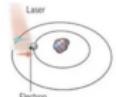
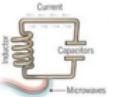
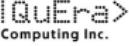


The 13 major NQI research centers and their affiliates ([quantum.gov](https://quantum.gov))

\*Blue dots on the map correspond to "Federal Quantum Programs"



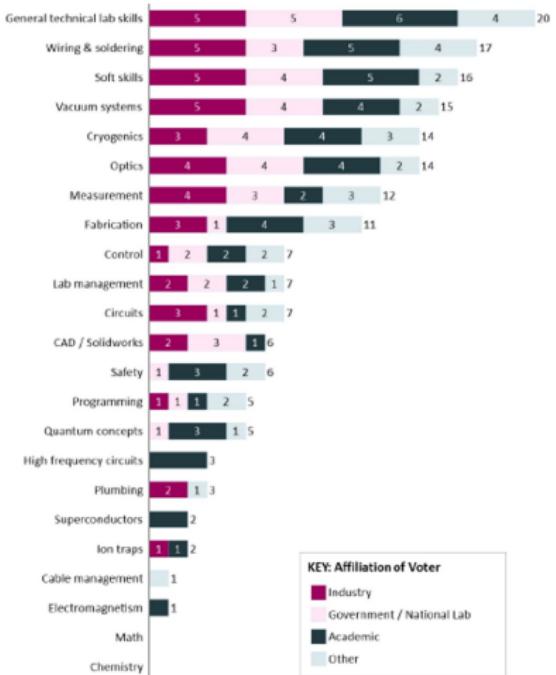
# Introduction

Neutral Atom	Trapped Ion	Photonics	Superconducting	Silicon Spin / Quantum Dots
<p>Neutral atoms are cooled using tuned laser and store qubits within electron states. Interactions through excitation to Rydberg states.</p> 	<p>Trapped Ion technology uses charged atomic particles, which can be confined and suspended in free space using electromagnetic fields. Qubits are stored in the stable electronic states of each ion. Lasers are used to induce coupling</p> 	<p>Photonic-based technology consists of superpositions of multiple photons in a light pulse. Qubits consist of so-called "squeeze states" consisting of superpositions of multiple photons in a light pulse</p> 	<p>Resistance-free current oscillations back and forth around a circuit loop. An injected microwave signal excites the current into superposition states.</p> 	<p>"Artificial atoms" are made by adding an electron to a small piece of pure silicon. Microwaves control the electron's quantum state.</p> 
<p><b>Pros:</b> Long coherence times. Strong connectivity including more than 2Q. External cryogenics not required.</p> <p><b>Cons:</b> Requires ultra-high vacuum. Laser scaling challenges.</p>	<p><b>Pros:</b> Extremely high gate fidelities and long coherence. No External cryogenics.</p> <p><b>Cons:</b> Slow gate times / operations. Low connectivity between qubits. Requires ultra-high vacuum. Laser scaling challenges.</p>	<p><b>Pros:</b> Extremely fast gate speeds and promising fidelities. No cryogenics or vacuum. Leverage existing CMOS fabs.</p> <p><b>Cons:</b> Noise from photon loss. Each program requires custom chip. Photons don't naturally interact so 2Q gate challenges.</p>	<p><b>Pros:</b> High gate speeds and fidelities. Leverage existing lithographic processes.</p> <p><b>Cons:</b> Requires cryogenic cooling. Short coherence times. Microwave interaction not well understood.</p>	<p><b>Pros:</b> Leverage existing semiconductor technologies. Strong gate fidelities and speeds.</p> <p><b>Cons:</b> Requires cryogenics. Only a few entangled gates with low coherence times. Interference and cross-talk challenges.</p>
    	   	  	     	    



# Introduction

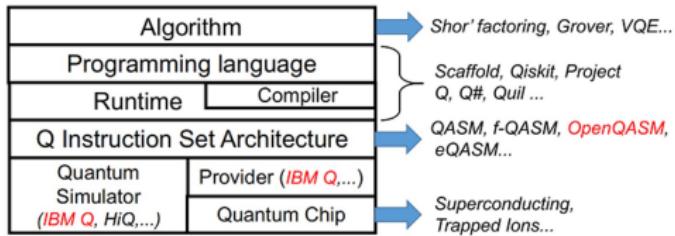
## Quantum Technician Skills





# Introduction

## Quantum Programming Languages



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# Introduction

## CNM Partnerships



Elevate  
Quantum

Elevate Quantum's mission is to unite Colorado, New Mexico, and Wyoming to secure the Mountain West's position as the global epicenter for Quantum development and enhance US economic and national security.



### Quantum Systems Accelerator

Catalyzing national leadership in quantum information science to co-design the algorithms, quantum devices, and engineering solutions needed to deliver certified quantum advantage in Department of Energy Office of Science scientific applications.



Berkeley

Caltech

HARVARD UNIVERSITY





# Introduction

## Quantum Learning Lab (QuLL)

- Sandia National Labs and CNM Partnership
- Training lab for Quantum Workforce Development located at the FUSE Makerspace in downtown ABQ
- Provide hands-on quantum experience for University and Community College students across the state
- Enhance knowledge of early-stage researchers and entrepreneurs



- Immersive Hands-On Workforce Training (10-weeks)
  - Built on the success of CNM Ingenuity's Deep Dive Bootcamps
  - No prior math/science needed

- Focus on:

- Optics and Photonics
- Ultra-High Vacuum Systems
- Quantum Phenomenon
- Problem Solving, Documentation, Math, Statistics

- Skills applicable to adjacent industries
  - Semiconductor, Solar Cell, Opto-Electronic Manufacturing

- CPL opportunities with Engineering Technician (and more)

## Quantum Technician Bootcamp





# Introduction

## Carpe Diem

- Quantum Information Systems industry is poised to revolutionize computing, sensing, and communications
  - > Solve complex optimization problems, provide ultra secure communications, radical new sensing capabilities
- National Priority: Quantum is the next technology “Space Race”
- New Mexico is positioned to attract Quantum employers and grow a Quantum economy
  - > Quantum capabilities at the SNL, LANL, AFRL, and Research Universities
  - > Elevate Quantum Tech Hub: CNM Ingenuity is the workforce co-lead
  - > Strong support from the Governor and State Legislature
- Today, 95% of Quantum jobs require advanced degrees; however, in 5-10 years 75% of the Quantum jobs will be certificates, associate, or bachelor degrees.
  - > The Quantum Technician Bootcamp is one of the first/only programs in the country focused on the technician workforce
- We need to build a workforce by training quantum-ready technicians for adjacent industries
  - > Jobs exist today in semiconductor, solar cell, opto-electronics and space.
  - > A quantum-ready workforce is an enabler to NM to attract Quantum companies
- Quantum Technician Bootcamp is part of a portfolio of CNM offerings for an advanced manufacturing workforce

### STA - Mechatronics

Industrial Technician  
Industrial Automation Technician

### Ingenuity

Internet of Things  
Quantum Technician

### Math Science Engineering

Engineering AS degree  
Engineering Technician

### BHT – CS/CIS

Internet of Things  
Industrial Automation



# What you will learn

- Optics
- Lasers / Photonics
- Ultra-High Vacuum Systems
- Quantum Phenomenon
- Applied Mathematics
- Structured Problem Solving



# Brightspace

The screenshot shows the CNM Brightspace homepage. At the top, there is a navigation bar with links to various CNM services like oPhysics, CNMI Deep Dive, CNM Ingenuity, Instances | Brev.dev, Quality Assurance, EC, and Markdown Live. Below this is a secondary navigation bar with links for Email, myCNM, CNM Brightspace, and language options (En Español, MAP). The main content area features the CNM logo and navigation links for Students, Programs, Workforce & Community, About CNM, and Help. A search bar at the top right contains the URL mycourses.cnm.edu/d2l/home/214794. Below the search bar is another navigation bar with links to oPhysics, CNMI Deep Dive, CNM Ingenuity, Instances | Brev.dev, Quality Assurance, EC, Markdown Live, Orders - Bambu L, and a Login link. The main content area displays a banner for the "Deep Dive Quantum Technician Bootcamp S..." with a start date of September 2025. The banner features a background image of quantum interference patterns. At the bottom, there is a footer navigation bar with links for Course Home, Course Work, Communication, My Grades, Resources, Course Admin, and Course Tools. On the right side of the footer, there is a user profile for BRIAN RASHAP and a gear icon for settings.



# Solidworks - Windows Users

To install Solidworks (Windows only), go to

<http://www.SolidWorks.com/SEK>

- Enter your contact information.
- Check the radio button “Yes” under ”I already have a Serial Number that starts with 9020”.
- Select the version: 2024 SP5.0 and click Request Download.
- On the next page, Accept the agreement and continue.
- On the final page, click the Download button to download the SolidWorks Installation Manager.
- Unzip the files to launch the Installation.
- Select the option for Individual/On this machine.
- Install using the following serial number provided by your instructor.



# Other Software

## ① Bambu Studio

- <https://bambulab.com/en/download/studio>

## ② Microsoft Excel

- <https://office365.com>
- Log in with your CNM credentials
- Download excel (and any other office programs)

## ③ Adobe Illustrator

- <https://adobe.com/creativecloud>
- Log in with your CNM credentials
- Select Work/School account

## ④ Octave

- <https://octave.org/download>

## ⑤ Bookmark the following:

- <https://www.desmos.com>
- <https://quantum.cloud.ibm.com/composer>
- <https://colab.research.google.com>

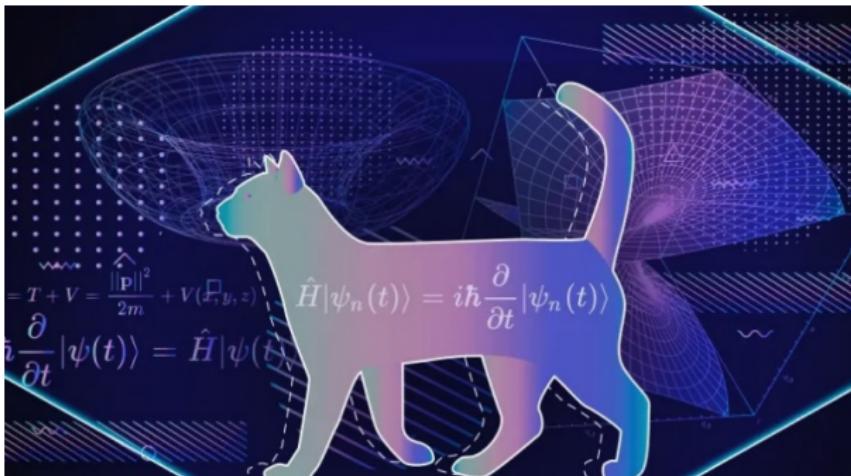


# Inaugural Cohort





# Pre Knowledge Check



- We are assuming no prior knowledge
- Pre and Post check will be used to help instructional team for future cohorts
- D) I am not familiar with this concept is an option on every question